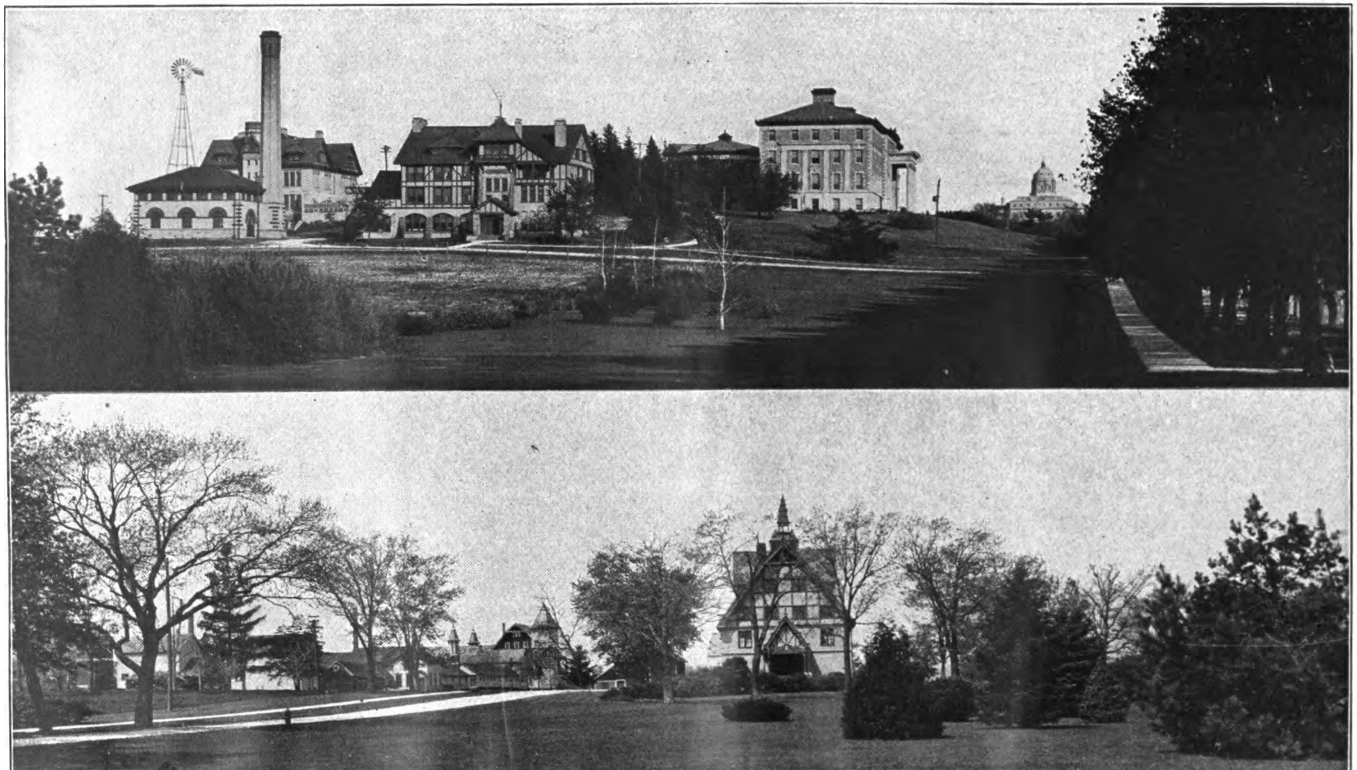

Buildings and Barns Connected with the Wisconsin Experiment Station.

TWENTY-THIRD ANNUAL REPORT

OF THE

Agricultural Experiment Station

OF THE

UNIVERSITY OF WISCONSIN

For the year ending June 30, 1906.

MADISON
DEMOCRAT PRINTING COMPANY, STATE PRINTER
1906

☞ The Bulletins and Annual Reports of this Station are sent free to all residents of the State upon request.

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NELLIE E. GRIFFITHS, ... Clerk and Stenographer.

General Offices and Departments of Agricultural Chemistry, Animal Husbandry, Bacteriology, Farmers' Institutes and Library, in Agricultural Hall, west of University Hall.

Dairy Building and Joint Horticulture-Physics Building, west end of Observatory Hill, near Agricultural Hall; Agricultural Engineering and Agronomy Buildings, south of Agricultural Hall.

Telephone connections to Station Offices and Barns.

LETTER OF TRANSMITTAL.

PLYMOUTH, WISCONSIN, October 11, 1906.

To His Excellency, James O. Davidson,

Governor of Wisconsin.

I have the honor to transmit to you herewith, in accordance with law, the Twenty-third Annual Report of the Agricultural Experiment Station of the University of Wisconsin.

Respectfully,

M. C. Mead,

President of the Board of Regents.

REPORT OF THE DIRECTOR.

The Twenty-Third Annual Report of the Experiment Station covers the fiscal year ending June 30, 1906. The subject matter embraces reports on the various investigations conducted in the several departments during the past year and in some instances summarizes efforts covering a number of years.

Changes in Station Staff.—The following changes have occurred since the last report:—

Instructor C. A. Ocock, B. S., has been given charge of the Department of Agricultural Engineering in place of Assistant Professor G. N. Knapp, withdrawn.

E. B. Hart, B. S., Associate Chemist, New York Experiment Station, Geneva, has been appointed Professor of Agricultural Chemistry in the College, and Chemist in the Station.

Mr. E. J. Delwiche, B. S., who was graduated with the class of 1906, of this College, has been given immediate charge of the three Superior sub-station farms, with headquarters at Iron River.

Mr. A. F. McLeod, Ph. D., a graduate of the University of Chicago, has been appointed Instructor in Soils in the College and Assistant in Soils in the Station.

Mr. L. H. Adams, for twenty-five years connected with the University Farm, and of late years, Farm Superintendent, closed his service June 15, 1906, to engage in farming on his own account.

Miss Iva A. Welsh, B. L., a graduate of the University, and for the past eight years connected with the State Historical Library, has been appointed librarian in place of Mrs. S. M.

Briggs, who resigned to take charge of the University Law Library.

Mr. Conrad Hoffmann, B. S., of the graduating class of 1906, this College, has been appointed Assistant in Agricultural Bacteriology.

Mr. C. Schroeder, B. S., also a member of the last graduating class, was made Assistant in Animal Husbandry, in place of James Hutton, who left us for a similar position in the Colorado Agricultural College.

William E. Tottingham, B. S., Assistant Chemist, New York Experiment Station, Geneva, has been appointed Instructor in Agricultural Chemistry in the College and Assistant in Chemistry in the Station, in place of Instructor J. C. Brown, who resigned to pursue practical work in dairying.

Instructor W. S. Brown, of the Horticultural Department, has withdrawn to engage elsewhere.

Roy T. Harris, who has, for several years, assisted in dairy tests and feed inspection, has been given the position of Official Dairy Tester.

James G. Milward has been appointed Assistant in Horticulture.

Buildings.—More than a year ago the University purchased three acres of land lying immediately south of the Linden Drive. On this tract there is now being erected a building for the Department of Agronomy, and a building for the Department of Agricultural Engineering. These two structures of brick, cement, steel, and tile, are of fire-proof construction. While the contract calls for their completion by January 1, 1907, the scarcity of labor so delays their construction that they will probably not be ready for occupancy before the summer of 1907. Through the addition of these two buildings, our facilities for instruction and research will be materially increased in two lines of great importance to the agricultural interests of the state.

Land Purchases.—Besides the tract mentioned in the preceding paragraph, the University has secured a tract of two and three-fourths acres, lying within the city limits, corner-

ing with Linden and Box Elder Drives. This tract, close to the agricultural buildings, will prove exceedingly useful to the College and Station in the future.

Our land property has been further augmented by the purchase of a tract of thirty acres, known as the Alvers land, adjoining the University Farm proper along its western border. This last addition will be used for general farm purposes. We now use as a part of the farm, thirty acres of land, constituting a portion of what is known as Camp Randall, which was purchased years ago for University purposes outside the College and Station. This holding must now be released by us.

In adopting the policy of increasing the land holdings of the University, the Regents have shown the highest wisdom and foresight. From time to time the available areas of the University Farm have been encroached upon by buildings, drives, and parks. This is as it should be, and no complaint is uttered. The requirements of the College for instruction and research have been greatly hampered by these moves, but all can be made more than good by the purchase of additional land from time to time.

Correspondence.—A considerable part of the office work of the Station is due to the ever-expanding usefulness of the Experiment Station in helping our farmer constituents through correspondence. To show how rapidly our duties in this single line are increasing, the following data are presented:—

During the year 1901, there were sent out from the Agricultural College and Experiment Station, 7,600 letters; during the year 1905, 15,650 letters were sent. On an average, 300 mimeograph sheets were prepared each working day of the past year. During the year we have had over 12,000 visitors, more than 1,200 of whom were from other states and foreign countries.

Agricultural Bacteriology.—Research efforts in bacteriology have moved mostly along two lines during the year—namely, Swiss cheese investigations and studies in bovine tuberculosis. The Swiss cheese problems have been discussed in Bulletin No. 128, "A Swiss Cheese Trouble Caused by a Gas-Forming Yeast" (English and German editions.)

In coöperation with the State Live Stock Sanitary Board, the work of locating and determining the prevalence of tuberculosis among cattle, and eradicating the same, when found, is expanding with great rapidity. Through the helpful aid of the United States Bureau of Animal Industry of the Department of Agriculture, Washington, this Station is supplied, free of charge, with the Koch tuberculin lymph for detecting and determining tuberculosis in cattle. For the period of ninety days, ending May 15, 1906, there were sent out to the dairymen of the state, by our Bacteriological Department, over 5,500 doses of tuberculin lymph. By this means, 600 animals, nearly all dairy cows, were found to be afflicted with the dread disease, and these were destroyed by order of the state authorities. The vigorous work of the Department and the State Live Stock Sanitary Board is meeting with hearty, appreciative response among dairymen.

It is both important and satisfactory to report that the interest awakened in the subject of bovine tuberculosis is brought about largely through direct demonstrations to farmers and stockmen. During the fall of 1905, examinations and slaughter tests of animals afflicted with tuberculosis were conducted by this College on the State Fair grounds, Milwaukee, during fair week, in conjunction with the State Veterinarian. At various times, such demonstrations have likewise been given at the Agricultural College before assemblages of agricultural students, the State Legislature, and the general public. These ocular demonstrations have, very naturally, done much to dispel prejudice, and have awakened an intelligent interest among those who should very properly be alive to the dangers of this dread scourage. The matter has now grown to such magnitude that the Station should hereafter receive state aid for this special work.

Agricultural Chemistry.—Numerous lines of effort by this Department are represented in the present report.

The official testing of dairy cows has occupied much time. Great good is being accomplished by this effort.

The inspection of commercial feeding stuffs and commercial

fertilizers has progressed satisfactorily, and is steadily becoming more rigid. Farmers and dealers are coming to realize more and more the importance and necessity for such inspection. The enforcement of the law works great good to honest dealers, as well as to all buyers.

The Sugar Beet Industry.—The Chemical Department of the Wisconsin Agricultural Experiment Station has persevered for seventeen years in a carefully planned study of the beet root for sugar production. Its first efforts were mainly to determine whether or not beets, with a good sugar content, could be grown within our borders. The great question was—"Are Wisconsin soils and climate suited to this most highly bred plant?" The results of these years of study, conducted by the Chemical Division in every county in the state, have shown beyond question that Wisconsin is one of the best sugar beet states in the Union, the tonnage of beets, the sugar content, and the purity of the juice all being satisfactory. When this fact was apparent, we undertook a campaign of general education. From time to time bulletins were issued and widely scattered, telling farmers and manufacturers of the results of our studies. Efforts were made to interest capitalists in the enterprise. It is both a pleasure and satisfaction to report that there are now established and in successful operation in our state four beet sugar factories, located at Menomonee Falls, Janesville, Chippewa Falls, and Madison. The last named factory is being operated the present fall for the first time. At Menominee, Michigan, there is a large factory, which draws most of its beets from Wisconsin farms. Thus, we have practically five sugar factories using Wisconsin beets. The output of these factories for the campaign of 1906-07 may be placed at 35,000,000 pounds of granulated white sugar, worth over one and one-half million dollars. Wisconsin farmers will receive well towards a million dollars for their beets the present year. Not only will this large sum of money be added to our agricultural income, but it will have been secured without a loss or injury to our other agricultural industries, for we will produce as much milk, butter, cheese, potatoes, tobacco, live stock, etc.,

as if there were no beet factories in the state. Thus, Wisconsin farmers are, practically, a million dollars better off this year because of this industry, the foundations of which were laid by the Wisconsin Experiment Station seventeen years ago.

Agricultural Engineering.—As soon as the building now in process of erection for this Department is completed, systematic research work with certain lines of farm machinery will be undertaken.

Some work has been carried on with cement for various purposes, especially in the construction of farm fence posts, the results of which will be presented later.

One line in which we hope to render efficient aid to agriculture is in the construction and maintenance of country earth roads, as well as other more expensive forms of highways.

Agronomy.—Extensive studies for improvement of grains and forage plants through hybridization, and especially by selection, are in progress. Many varieties of oats, barley, rye, and corn were grown in plats during the year, in the effort to secure or fix superior strains. These studies will, in time, certainly increase the grain yields of Wisconsin farms.

The United States Department of Agriculture has agents scattered throughout the world diligently searching for superior varieties of grains and economic plants for the benefit of American agriculture. In 1899 this Station secured from the Department at Washington many samples so gathered, among them being one of oats found by a government agent in Russia. This seed was sown in a plat, along with others, to test its value, and at harvest time showed superiority. The variety was accordingly multiplied as rapidly as possible. Further tests were conducted at several points in the state, mainly by former Short Course students of our College, and the seed finally distributed in quantity over the state. So successful has this effort been that it is estimated that for the year 1905 there were produced in the state of Wisconsin not less than 10,000,000 bushels of the White Swedish oats, as this

variety is called, or about one-tenth of the oat yield of the state. As above stated, all this vast quantity of grain was derived, so far as our state is concerned, from two pounds of seed oats supplied by the United States Department of Agriculture, and first sown on the University Farm in 1899. The great value of the National Department of Agriculture to the American farmer, and the importance of close association and coöperation of the state experiment stations with that Department, is splendidly illustrated by this example.

In 1898 the Agronomy Department secured a sample of barley, known as the Oderbrucker, from the Ontario Agricultural College, Guelph, Canada. This barley is rich in protein. Protein-rich barleys have heretofore generally been held as poor and unsatisfactory for brewing purposes. During the past two years, 100 bushels of this barley has each year been furnished the Wahl-Henius Institute of Fermentology, Chicago, for brewing tests. The results of these tests have been entirely satisfactory for this variety, and show that protein-rich barleys are not necessarily undesirable for brewing purposes.

During the spring of 1906, the Station distributed 600 bushels of the Oderbrucker barley among 250 members of the Agricultural Experiment Association. Thus, this valuable grain is rapidly being widely disseminated among the farmers of the state.

Animal Husbandry.—A number of experiments have been conducted in the Animal Husbandry Department, as shown by the present report. We have now reached our limit of accommodations for herds and flocks. There should be added, at an early date, a large stock barn, and at our second, or "Hill Farm," a barn should be built for the accommodation of animals kept there when not needed for instructional or research purposes at the University Farm proper.

Dairying.—Among the researches of the Dairy Department is that of a study of the manufacture of whey butter in the Wisconsin Swiss cheese factories, as reported in Bulletin No. 132, printed in English and German editions.

Another study is the proper disposal of creamery sewage.

This last is a joint effort by the College of Engineering and the departments of Dairying, Bacteriology, and Chemistry of this College. A sewage plant, located at a point north of the Dairy building, has been built at considerable expense, and studies are being conducted, bearing on the proper disposition of creamery sewage. The problem is a difficult one, and no results can be reported at this time.

Horticulture.—The extensive work of improving the wild plum, begun by the late lamented Professor Goff, is nearing the close. Several varieties of excellent, hardy, prolific plums are the result. A number of promising apples have likewise been developed from seedlings secured by Professor Goff. These efforts are doing much to stimulate the growing of these valuable fruits in the state. Another study is to determine the effects of low temperatures on the winter destruction of apple trees.

A work of scientific value, is producing marked variations in the leaves and fruits of the tomato, by supplying an abnormal amount of rich plant food to the growing plants. By this means, seedless tomatoes have been produced. The results have been verified by repetition.

A useful line of extension work is the prevention of the dread potato blight by spraying the growing vines with the Bordeaux mixture. Potato spraying experiments with power machines have been carried on during the past season in Columbia, Portage, and Burnett counties. Nursery inspection has been continued, as directed by law. Tobacco investigations have been continued along several lines. A tobacco steam-curing house has been constructed and put in use during the fall of 1906.

During the past three years, over 400 pounds of tobacco seed, of improved strains, have been distributed among tobacco growers of the state.

Horse Breeding.—The passage of the law requiring that all stallions, for which service fees were charged, in the state, shall be licensed by the College of Agriculture, is working well for a first effort in this line. Over twenty-six hundred stallions have been licensed. Unfortunately, considerably more

than half of these are shown by the registration to be grades. The effect of the law has been to materially decrease the number of inferior stallions in the state. It is hoped that the coming legislature will strengthen the law, and that such action will receive the hearty support of all lovers of the horse. No state in the union offers better opportunity for the profitable rearing of carriage and draft horses of merit and worth than does Wisconsin. The whole enterprise rests primarily upon the quality of the stallions used for breeding purposes. When this fact is duly recognized by our farmers and stockmen, the value and importance of stallion registry by the College, under the proper provisions of law, become at once apparent. All citizens of the state who take a real interest in the improvement of the horse should stand by the law and see that it is strengthened.

Soils.—The Department of Soils has rendered valuable assistance during the past year to both large and small drainage companies operating at various points in the state. Wisconsin has 1,500,000 acres of low-lying lands still undeveloped because of excess moisture. In some cases, where the areas are large, drainage districts are being formed, bonds issued, and the proceeds used for cutting large main ditches, or canals, for carrying off the water. The Department is of the highest service to the land owners of these districts, in enabling them to lay their plans and have them carried out in an economical, business-like manner.

The cranberry station, at Cranmoor, directly in charge of the Department of Soils, is conducting useful studies of that valuable and important fruit. The industry in this state is in the hands of an intelligent, united force of growers, who strongly sustain the cranberry station in its efforts. The combination is most fortunate, and the results of these united efforts should place Wisconsin in the lead as a cranberry-producing state within the next few years.

The Soils Department has undertaken, in a large way, a study of the soils in several parts of the state, with a view of ascertaining their defects, and how better conditions may be

attained by the farmers. Marsh soils, and especially sandy soils, are receiving studious attention, the investigations being carried on not only through laboratory studies but by extensive tests of the soils themselves, by growing crops thereon, with and without the addition of special elements of fertility. The undertaking is steadily developing into a soil survey of the whole state.

Branch Stations.—An important line of work, undertaken during the year, was the establishment of three branch stations in the region south of Lake Superior, one on the County Poor Farm, in Douglas county, a second within the corporation limits of Iron River, Bayfield County, and a third within the city limits of Ashland, Ashland County. The Lake Superior district is peculiar to itself, comprising a level, stiff, red clay soil region, formerly covered with forests. Fire, following the lumberman's axe, left it desolate; stumps and the burned stubs of dead trees and brush cover most of the land at this time. Here and there a settler has made a clearing and turned over the red soil. Properly managed, this clay soil yields large crops of clover and timothy, as well as oats and barley. A number of peculiar problems present themselves with respect to this soil. Under certain conditions, it holds the water tenaciously; the surface soil puddles and bakes, thereby checking the free germination of seed grain or grasses. This and other difficulties must be overcome before the region is entirely satisfactory for agriculture. Tile drains have been laid at the Superior farm and are beginning to work satisfactorily. The possibilities and benefits of drainage will be studied at both the Douglas and Ashland county farms. Crop tests are in progress.

The Iron River country represents more than a million acres of sandy soil, quite different from the clay region lying northward. It is believed that this district can be made profitable agriculturally, through the growth of red clover to enrich the soil, through the production of potatoes, clover seed, etc., as leading market crops, and through sheep husbandry and dairying as the leading lines in animal husbandry.

In inaugurating work on these branch stations, we have had the most helpful assistance from citizens in the districts named, and everything has been done in a broad way without reference to any particular individual, but rather to make the possible beginnings of real agricultural development in this large region. A study of this section showed us that outside of several large cities on the south shore of Lake Superior, the region was yet a wilderness, with only here and there a pioneer farmer. While thousands of land seekers are pushing to the far north, here is a great undeveloped agricultural district receiving no attention from those sweeping by. It is hoped that our sub-station farms will show that agriculture can be carried on profitably in this region, embracing several million acres of land, splendidly located as to markets, on the south shore of Lake Superior.

In aid of the same region, the Horticultural Department has planted an orchard at Bayfield, and another on Apostle Island. It is believed that the elevated lands near Lake Superior possess some unusual advantages for the fruit grower through the ameliorating influences of that large body of water on trees and vines, and because of the excellent markets in the cities of the North. Orchard trees have also been planted on the Douglas County farm.

These sub-stations are under the joint care of the departments of Agronomy, Horticulture, and Soils.

Publications issued by the Agricultural Experiment Station, July 1, 1905, to June 1, 1906.

Serial number of bulletins.	Title.	Edition	Pages.	Total pages.
127	The Principles and Practice of Horse-Breeding	40,000	128	5,120,000
128	A Swiss Cheese Trouble Caused by a Gas-Forming Yeast (English and German editions)	7,500	26	195,000
129	Some Creamery Problems	25,000	26	650 000
130	Licensed Commercial Feeding Stuffs, 1905	18,000	70	1,260,000
131	Official Tests of Dairy Cows	18,000	46	878,000
132	The Manufacture of Whey Butter at Wisconsin Swiss Cheese Factories (English and German editions)	10,000	32	320,000
133	Distribution of Tuberculosis in Suspected and Non-suspected Herds in Wisconsin	25,000	15	375,000
134	Licensed Commercial Fertilizers and Feeding Stuffs, 1906	18,000	30	750,000
135	The Spraying of Potatoes for Prevention of Leaf Blight and Rot	25,000	24	600,000
136	Directions for Making Jellies and for Preserving Fruits and Vegetables	25,000	16	400,000
137	Conditions which Effect the Time of Annual Flowering of Fruit Trees	8,000	24	192,000
		219,500	437	10,740,000
	Twenty-Second Annual Report	15,000	397	5,955,000
	Total	234,500	834	16,695,000

Thus it is seen that during the year there were prepared and published by the Station staff 834 pages of original matter, embraced in 234,500 copies of the annual report and the bulletins. The total pages published aggregated 16,695,000. This shows that the Station sent out, on the average, nearly 800 bulletins and reports for each working day of the year. In addition to this a large amount of mimeograph matter was sent to the press of the state for publication through that valuable medium.

LIST OF BULLETINS ISSUED BY THE WISCONSIN AGRICULTURAL EXPERIMENT STATION, 1883-1906.

*No. 1. Sweet Skim Milk; Its Value as Food for Pigs and Calves.
*No, 2. Amount and Condition of Seed Corn in Wisconsin.
*No. 3. Composition and Digestibility of Fodders.
*No. 4. Experiments on Milk Production.
*No. 5. Analyses of Feeding Stuffs.
*No. 6. Experiments on Calf-feeding: Analyses of Fertilizers.
*No. 7. Experiments on Calf-feeding: The Cooley System of Creaming Milk.
*No. 8. Oil Meal vs. Corn Meal for Milk.
*No. 9. Report on Oats, Potatoes, and Corn for 1885.
*No. 10. Tests of Dairy Cows.
*No. 11. Report on Wheat, Oats, Barley, Potatoes, and Corn for 1886.
*No. 12. The Oil Test for Cream.
*No. 13. Report on Wheat, Oats, Barley, Corn, and Potatoes for 1887: The Station Vineyard.
*No. 14. Artificial Fertilizers and Land Plaster.
*No. 15. Ensilage vs. Corn Fodder for Milk Production.
*No. 16. A New Method for Determining Fat in Milk.
*No. 17. Report on Corn, Oats, Barley, and Potatoes: Grape Growing
*No. 18. The Constitution of Milk, and Some of the Conditions which Affect the Separation of Cream.
*No. 19. Notes on Ensilage.
*No. 20. Noxious Weeds of Wisconsin.
*No. 21. Comparative Value of Warm and Cold Water for Milch Cows in Winter.
*No. 22. Report on Oats, Barley, and Potatoes for 1889.
*No. 23. Prevention of Apple Scab.
*No. 24. A New Method for the Estimation of Fat in Milk, Especially Adapted to Creameries and Cheese Factories.
*No. 25. Feeding Bone Meal and Hard Wood Ashes to Hogs Living on Corn.
*No. 26. Sugar Beet Culture in Wisconsin.
*No. 27. The Feeding Value of Whey.
*No. 28. The Construction of Silos.
*No. 29. Creaming Experiments.
*No. 30. Sugar Beet Experiments in Wisconsin for 1891.
*No. 31. Notes on the Use of the Babcock Test and the Lactometer.
*No. 32. Feeding Grain to Lambs.
*No. 33. Rations for Dairy Cows.

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*Out of print.

*No. 34. Preventive Treatment for Apple Scab, Downy Mildew and Brown Rot on the Grape, Pototo Blight, and the Smut on Wheat and Oats.

*No. 35. Insects and Diseases Injurious to Cranberries.

*No. 36. Directions for Using the Babcock Milk Test and the Lactometer.

*No. 37. The Russian Thistle.

*No. 38. One Hundred American Rations for Dairy Cows.

*No. 39. Noxious Weeds.

*No. 40. Tuberculosis and the Tuberculin Test.

*No. 41. Grain Feeding Lambs for Market.

*No. 42. Destructive Effects of Winds on Sandy Soils and Light Sandy Loams, with Methods of Protection.

*No. 43. The Agricultural, Horticultural and Live-Stock Features of a Portion of Wisconsin Tributary to Superior.

*No. 44. Pasteurization of Milk and Cream for Direct Consumption.

*No. 45. Apple Culture.

*No. 46. Power Tests of Centrifugal Cream Separators.

*No. 47. Wisconsin's Fertilizer Law.

*No. 48. The Conn Culture (B. 41) in Butter-Making.

*No. 49. The Maintenance of Soil Fertility: Commercial Fertilizers.

*No. 50. The Hot Water Treatment for the Prevention of Smut on Oats, Wheat and Barley.

*No. 51. The Marls of Wisconsin.

*No. 52. A Comparison of the Babcock Test and the Gravimetric Method of Estimating Fat in Skim Milk.
The Alkaline Tablet Test of Acidity in Milk or Cream.

*No. 53. Analyses of Licensed Commercial Fertilizers.

*No. 54. The Restoration of the Consistency of Pasteurized Cream.

*No. 55. Beet Sugar Productions: Possibilities for a New Industry in Wisconsin.

*No. 56. Statistics from Fifty-two Wisconsin Separator Creameries.

*No. 57. Analyses of Licensed Commercial Fertilizers.

*No. 58. The Rape Crop, Its Growth and Value for Soiling and Fattening Sheep and Swine.

*No. 59. The Construction of Silos and the Making and Handling of Silage.

*No. 60. The Cheese Industry: Its Development and Possibilities in Wisconsin.

*No. 61. The Constitution of Milk, with Especial Reference to Cheese Production.

*No. 62. Tainted or Defective Milks: Their Causes and Methods of Prevention.

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* Out of print.

*No. 63. The Culture of Native Plums in the Northwest.
*No. 64. Sugar Beet Investigation in Wisconsin During 1897.
*No. 65. A Bacterial Rot of Cabbage and Allied Plants.
*No. 66. Analyses of Licensed Commercial Fertilizers.
*No. 67. Factory Tests for Milk.
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*No. 70. Construction of Cheese Curing Rooms for Maintaining Temperatures of 58 Degrees to 68 Degrees F.
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*No. 75. Testing Cows at the Farm.
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*No. 87. Native Plums.
*No. 88. Dairy Industry in Wisconsin.
No. 89. The Law Regulating the Sale and Analysis of Concentrated Feeding Stuffs in Wisconsin.
*No. 90. Concentrated Feeding Stuffs and Fertilizers Licensed for Sale in Wisconsin, 1902.
*No. 91. Oat Smut in Wisconsin.
No. 92. Licensed Commercial Fertilizers and Concentrated Feeding Stuffs, 1902.
*No. 93. Development and Distribution of Nitrates in Cultivated Soils.
No. 94. Curing of Cheddar Cheese, with Especial reference to Cold-Curing.
No. 95. Some Observations on Sheep Breeding from the Experiment Station Flock Records.

*Out of print.

*No. 96. Investigations of Methods of Milking.
No. 97. Licensed Commercial Feeding Stuffs, 1902.
*No. 98. On the Prevention of Oat Smut and Potato Scab.
*No. 99. Concentrated Feeding Stuffs and Fertilizers Licensed for Sale in Wisconsin, 1903.
No. 100. Licensed Commercial Fertilizers and Feeding Stuffs, 1903.
*No. 101. Shrinkage of Cold-Cured Cheese During Ripening.
*No. 102. Studies in Milk Production.
*No. 103. Soiling Crops for Dairy Cows in Wisconsin.
*No. 104. The Food Requirements of Pigs from Birth to Maturity.
*No. 105. The Improvement of Home Grounds.
*No. 106. Licensed Commercial Feeding Stuffs, 1903.
*No. 107. Official Tests of Dairy Cows, 1902–03.
*No. 108. Trees and Shrubs for Shade and Ornament.
*No. 109. Concentrated Feeding Stuffs and Fertilizers Licensed for Sale in Wisconsin, 1904.
No. 110. Spraying Fruit Trees, With Notes on the Common Insects and Fungus Diseases Infesting Orchards.
No. 111. Oat Smut and Its Prevention.
*No. 112. Alfalfa in Wisconsin.
*No. 113. Licensed Commercial Fertilizers and Feeding Stuffs, 1904.
No. 114. A Lesson in Bovine Tuberculosis.
No. 115. The Quality of Cheese as Affected by Rape and Other Green Forage Plants Fed to Dairy Cows.
*No. 116. On the Relation of Food to the Production of Milk and Butter Fat by Dairy Cows.
No. 117. The Relation of Food to Dairy Production.
No. 118. Licensed Commercial Feeding Stuffs, 1904.
No. 119. A Report on Cranberry Investigations.
*No. 120. Concentrated Feeding Stuffs and Fertilizers Licensed for Sale in Wisconsin, 1905.
No. 121. Alfalfa, or Lucern.
No. 122. Licensed Commercial Fertilizers and Feeding Stuffs, 1905.
No. 123. The Beet Sugar Industry in Wisconsin.
No. 124. Report on Tobacco Investigations in Wisconsin for 1903 and 1904.
No. 125. Silo Construction.
No. 126. Two Ways of Treating Tuberculosis in Herds.
No. 127. The Principles and Practice of Horse-Breeding.
No. 128. A Swiss Cheese Trouble Caused by a Gas-Forming Yeast.
No. 129. Some Creamery Problems.
No. 130. Official Tests of Dairy Cows, 1904–1905.
No. 131. Licensed Commercial Feeding Stuffs.

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*Out of print.

No. 132. The Manufacture of Whey Butter at Wisconsin Swiss Cheese Factories.

No. 133. Distribution of Tuberculosis in Suspected and Non-Suspected Herds in Wisconsin.

No. 134. Licensed Commercial Fertilizers and Feeding Stuffs, 1906.

No. 135. The Spraying of Potatoes for Prevention of Leaf Blight and Rot.

No. 136. Practical Directions for Preserving Native Fruits and Vegetables.

No. 137. Conditions Which Effect the Time of the Annual Flowering of Fruit Trees.

No. 138. Land Drainage.

No. 139. The Principles and Maintenance of Soil Fertility.

No. 140. Development of Factory Dairying in Wisconsin, with Map Showing Location of Cheese Factories and Creameries.

No. 141. The Horse Breeding Industry of Wisconsin.

Reports and bulletins wanted.—We have many calls from public libraries, and from colleges and experiment stations, for copies of former reports and bulletins. The following are out of print and much desired:—Annual reports of the Agricultural Experiment Station, I, III, and IV; bulletins of the Agricultural Experiment Station, 1 to 15 inclusive; also 24, 31, and 59.

Friends of the Station who are not keeping files of our publications, are earnestly urged to return to us any copies they may have of the rare reports and bulletins. We will gladly pay a reasonable sum for any of the lacking numbers above noted. Readers should bear in mind that the documents asked for are Experiment Station bulletins and reports, and not bulletins of the Farmers' Institute, which is another branch of the College of Agriculture.

WHOLE CORN COMPARED WITH CORN MEAL FOR FATTENING PIGS, WITH SUMMARY OF TRIALS FOR TEN YEARS.

W. A. HENRY AND D. H. OTIS.

For the past ten years this Station has been testing the comparative value of whole corn and corn meal for fattening pigs. One or more tests have been made each year and the results recorded in Annual Reports Thirteenth to the present volume, inclusive.

With the exception of one year, the corn was supplemented with wheat middlings, and, in one instance, also with skim milk. Experience teaches us that corn, either whole or ground, as an exclusive diet, gives unsatisfactory results with fattening swine.

The work for the past year was conducted in three series.

FIRST FEEDING TRIAL OF THE YEAR.

This consisted of twenty-four pigs, farrowed in July, August, and September, 1905, and averaging 68 pounds in weight when the trial began. Previous to the trial, these pigs were fed on skim milk, middlings, and a little corn. They were divided into two lots, as nearly equal as possible in regard to breed, age, weight, and condition.

Lot I contained six pure-bred Poland Chinas, five pure-bred Berkshires, and one cross-bred Poland-China-Berkshire. Seven were barrows and five sows.

Lot II consisted of six Poland-Chinas, four Berkshires, and two cross-bred Poland-China-Berkshires. Nine were barrows and three sows.

All lots were kept in pens, 10 feet by 12 feet in area, opening into small yards on the south, which were protected by the surrounding buildings. The pigs were fed in adjoining pens constructed for feeding purposes, and used only at meal times. The sleeping pens were kept well cleaned and well bedded. Both lots of pigs had free access to charcoal, wood ashes, and salt.

The experiment began January 20, 1906. Lot I was fed shelled corn and heavy wheat middlings, equal parts by weight, with two pounds of skim milk daily per head. The shelled corn was fed first, and after it was consumed, the mixed middlings and skim milk were fed as a slop. Lot II was fed the same ration, except that corn meal, made from the same lot of corn as was fed Lot I, was substituted for the shelled corn. The corn meal, wheat middlings, and skim milk were mixed together and fed as a slop. The water added in making the slop was slightly warmed. Each lot had its ration weighed out twice daily, and was given what it would eat. The corn used in these trials was a yellow dent, grown near Madison in 1905. The following analysis of this corn was made by the Chemical Department from samples submitted near the middle of the feeding period.

TABLE I.—*Condition of the corn meal used in trials in feeding whole corn, in comparison with corn meal, to fattening pigs.*

Mechanical. (Showing fineness of grinding.)	Per cent.	Chemical.	Per cent.
Passed through sieve 20 meshes to the inch	19.0	Moisture	13.95
Passed through sieve 16 meshes to the inch	5.7	Protein	9.13
		Ether extract (fat)	3.26
Passed through sieve 12 meshes to the inch	27.7	Crude fiber	1.46
Passed through sieve 8 meshes to the inch	25.9	Nitrogen free extract	70.65
		Ash	1.55
Portion too coarse to pass through sieve 8 meshes to the inch	21.7		100.00
	100.00		

The pigs were weighed weekly. The feeding period lasted twelve weeks, and results obtained are recorded in the following tables:—

TABLE II.—*Results of feeding whole corn, in comparison with corn meal, to fattering pigs.*

LOT II.—Fed shelled corn, wheat middlings, and skim milk.

	Feed eaten.			S.* 300	S. 319	S. 320	B.† 322	S. 323	B. 324	B. 329	B. 331	S. 332	B. 336	B. 338	B 339	Total
	Shelled corn.	Wheat middlings.	Skim milk.													
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Weight at beginning, January 20	....	....	....	100	70	74	64	70	71	57	70	60	61	50	68	815
Feed eaten and gain:																
1st week	125.0	125.0	168	4	5	7	11	8	5	6	5	7	7	7	4	76
2nd week	129.2	129.2	168	8	7	6	10		9	6	6	4	6	7	9	86
3rd week	157.0	155.0	168	12	9	8	5	7	10	7	3	10	8	7	9	95
4th week	158.0	158.0	168	10	9	9	9	6	8	8	9	5	12	5	10	100
5th week	180.0	181.0	168	13	11	12	15	11	14	10	9	10	11	10	10	136
6th week	163.2	163.2	161	0	—6	4	4	11	10	6	1	6	8	9	8	61
7th week	169.7	169.7	168	14	12	10	12	9	13	7	9	12	10	8	9	125
8th week	186.2	186.2	168	11	3	7	10	5	5	3	0	1	6	1	6	58
9th week	201.2	201.2	168	13	8	13	10	6	3	12	8	9	14	14	10	120
10th week	223.0	223.0	168	13	10	8	13	11	15	9	8	5	10	12	12	126
11th week	233.2	233.2	168	14	9	8	8	7	11	9	5	12	7	7	8	105
12th week	243.5	243.5	168	5	13	11	12	11	13	1	1	10	16	12	12	117
Final weight	....	....	....	217	160	177	183	170	187	141	134	151	176	149	175	2,020
Feed eaten and gain	2,169.2	2,168.2	2,009	117	90	103	119	100	116	84	64	91	115	99	107	1,205

* S—Sow. † B—Barrow.

TABLE III.—*Results of feeding whole corn, in comparison with corn meal, to fattening pigs.*

LOT II.—Fed corn meal, wheat middlings, and skim milk.

	FEED EATEN.			*S 301	†B. 302	B. 321	B. 325	B. 326	B. 327	B. 328	B. 330	B. 333	B. 334	S. 335	S. 337	Total
	Corn meal.	Wheat middlings.	Skim milk.													
	Lbs.	Lbs.	Lbs.	Lbs	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Weight at beginning, January 20	....	....	....	105	84	76	85	74	58	66	53	48	61	61	51	822
Feed eaten and gain:																
1st week	128.0	128.0	168	9	2	3	10	7	4	4	4	4	3	5	6	61
2nd week	133.7	133.7	168	7	8	8	9	5	5	8	7	6	3	9	6	81
3rd week	164.7	164.7	168	9	11	8	8	14	7	9	9	6	10	8	6	105
4th week	161.0	161.0	168	10	15	10	12	7	8	11	8	9	8	3	7	108
5th week	188.0	188.0	168	10	10	12	15	13	18	9	11	13	11	10	9	141
6th week	187.5	187.5	161	10	10	11	4	6	5	12	7	3	6	4	0	78
7th week	199.7	199.7	168	16	19	2	9	11	7	8	10	13	14	12	11	132
8th week	211.7	211.7	168	9	14	15	10	6	8	9	8	6	8	4	—2	95
9th week	229.2	229.2	168	10	12	9	10	14	7	12	9	11	8	10	8	120
10th week	240.7	240.7	168	10	9	15	15	9	10	12	6	10	10	9	4	119
11th week	257.5	257.5	168	11	15	18	15	7	8	15	18	13	14	10	5	149
12th week	271.2	271.2	168	15	11	9	6	7	8	8	11	11	9	9	5	109
Final weight	....	....	....	231	220	196	208	180	153	183	161	153	165	154	116	2,120
Feed eaten and gain	2,372.9	2,372.9	2,009	126	136	120	123	106	95	117	108	105	104	93	65	1,298

*S—Sow. †B—Barrow.

A study of the results shows that:—

Lot I, fed shelled corn, wheat middlings, and skim milk, gained 1,205 pounds in weight, and consumed 4,337 pounds of grain and 2,009 pounds of skim milk. This lot required, therefore, 360 pounds of grain and 166 pounds of skim milk for each 100 pounds of gain made during the trial.

Lot II, fed corn meal, wheat middlings, and skim milk, gained 1,298 pounds in weight, and consumed 4,745 pounds of grain and 2,009 pounds of skim milk. This lot required 366 pounds of grain and 154 pounds of skim milk for each 100 pounds of gain made during the trial.

The lot fed corn meal consumed 408 pounds more grain, and gained 93 pounds more in weight than the lot fed shelled corn. It required 6 pounds more feed than the lot getting shelled corn, to make 100 pounds of gain.

SECOND FEEDING TRIAL OF THE YEAR.

Ten pigs, varying considerably in age, weight, and condition, were divided as nearly equal as possible into two lots of five each. Those in Lot III varied from 70 to 272 pounds, the average weight at the beginning of the trial being 184 pounds. Lot IV varied from 89 to 268 pounds, the average weight being 175 pounds. Lot III contained one Duroc-Jersey, one Berkshire, and three Cross-bred Poland-China-Berkshires, of which four were barrows and one a sow. Lot IV contained two Berkshires, one Duroc-Jersey, and two cross-bred Poland-China-Berkshires, all barrows.

Lot III was fed a grain mixture of two-thirds shelled corn and one-third heavy wheat middlings.

Lot IV was fed two-thirds corn meal and one-third heavy wheat middlings.

The methods of feeding, care, and management were the same as in the first trial. The results are recorded in the following tables:—

TABLE IV.—*Results of feeding whole corn, in comparison with corn meal, to fattening pigs.*

Lot III.—Fed shelled corn and wheat middlings.

	FEED EATEN.		*S. 1996	†B 351	B. 303	B. 314	B. 352	Total
	Shelled corn.	Wheat mid-dlings.						
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Weight at beginning, Jan. 20	......	......	216	70	173	272	187	918
Feed eaten and gain,								
1st week	129.0	66.5	9	4	7	11	11	42
2nd week	103.0	51.7	5	5	3	11	2	26
3rd week	135.2	74.5	10	4	6	16	10	46
4th week	131.7	62.0	10	5	9	5	3	32
5th week	152.5	77.2	10	9	14	20	13	66
6th week	139.0	67.2	2	8	8	15	8	41
7th week	146.0	72.5	18	10	15	12	13	68
8th week	147.2	72.5	—4	4	4	6	3	13
9th week	142.5	70.0	5	10	7	15	10	47
10th week	157.7	78.2	15	11	9	13	10	58
11th week	172.0	86.0	4	15	14	16	14	63
12th week	169.5	84.7	5	11	14	8	9	47
Final weight	......	......	305	166	283	420	293	1,467
Feed eaten and gain	1,727.3	863.0	89	96	110	148	106	549

*S—Sow. †B—Barrow.

TABLE V.—*Results of feeding whole corn, in comparison with corn meal, to fattening pigs.*

Lot IV.—Fed corn meal and wheat middlings.

	FEED EATEN.		*B. 176	B 313	B. 353	B. 354	B. 250	Total
	Corn meal.	Wheat mid-dlings.						
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Weight at beginning, January 20	......	......	220	268	89	93	205	875
Feed eaten and gain:								
1st week	131.2	66.7	12	16	—7	2	8	31
2nd week	130.	65.	9	13	15	4	14	55
3rd week	146.	73.	6	9	8	9	10	42
4th week	159.5	79.7	15	19	5	11	15	65
5th week	186.5	92.2	17	14	12	11	18	72
6th week	171.5	85.7	13	11	2	8	8	42
7th week	175.5	87.7	14	25	11	15	22	87
8th week	177.	88.5	9	5	6	5	6	31
9th week	180.	90.	13	10	9	12	14	58
10th week	193.	96.5	12	19	9	13	20	73
11th week	205.5	102.7	20	19	10	17	18	84
12th week	210.	105.	13	12	9	12	15	61
Final weight	....	....	373	440	178	212	373	1,576
Feed eaten and gain	2,065.7	1,032.7	153	172	89	119	168	701

*B.—Barrow.

A comparison of the results shows that:—

Lot III, fed shelled corn and wheat middlings, gained 549 pounds, and consumed 2,588 pounds of grain, or 471 pounds of grain for 100 pounds of gain.

Lot IV, fed corn meal and wheat middlings, gained 701 pounds and consumed 3,098 pounds of grain, or 442 pounds of grain for 100 pounds of gain.

The lot fed corn meal consumed 510 pounds more grain, and gained 152 pounds more in weight than the lot fed shelled corn. It produced 100 pounds of gain on 29 pounds less feed than did the lot fed shelled corn.

THIRD FEEDING TRIAL OF THE YEAR.

The comparative value of shelled corn, versus corn meal, was further tested during the summer of 1906 with hogs running on Dwarf Essex rape pasture. Twelve pigs, farrowed in August and September, 1905, and averaging 190 pounds in weight, were divided into two lots as nearly equal as possible as to breed, age, sex, weight, and condition.

Lot V contained four Poland-Chinas and two Berkshires, of which four were barrows and two sows.

Both lots were provided with an abundance of Dwarf Essex rape pasture and fresh water.

Lot VI contained five Poland-Chinas and one Berkshire, of which four were barrows and two sows.

Lot V was fed shelled corn and heavy wheat middlings. The wheat middlings was supplied as a thick slop, and after it was consumed, the shelled corn was scattered in the feed trough and on the feeding platform, where the pigs ate it leisurely.

Lot VI was supplied corn meal and wheat middlings, mixed together, and fed as a thick slop. Both lots were supplied with wood ashes and salt *ad libitum,* and had access to plenty of shade. During a few days the pigs suffered from the extreme heat. Wallows were provided, however, for each pen, and on the hotter days, they were allowed to spend a few hours in a running brook near the pens.

Both lots were fed twice daily. The feed was weighed at

the beginning of each week, and what was left over was weighed back at the end of the week. Each pig was weighed weekly. The results are given in the following tables:—

TABLE VI.—*Results of feeding whole corn, in comparison with corn meal, to fattening pigs.*

Lot V.—Fed shelled corn, wheat middlings, and Dwarf Essex rape.

	FEED EATEN.		*B 334	†S 335	S 320	B 330	B 325	B 324	Total
	Shelled corn.	Wheat mid-dlings							
	Lbs.	Lbs.	Lbs	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Weight at beginning, July 3	....	....	182	156	192	167	225	210	1,132
Feed eaten and gain:									
1st week	100	50	7	7	7	4	7	8	40
2nd week	150	75	13	4	3	6	10	10	46
3rd week	150	75	10	3	14	9	10	14	60
4th week	150	75	6	5	4	5	6	6	32
5th week	150	75	16	15	14	20	17	16	98
6th week	200	100	9	....	11	6	4	7	37
7th week	200	100	7	9	11	10	14	9	60
8th week	200	100	5	8	10	10	13	11	58
9th week	200	100	—10	6	13	14	13	23	59
10th week	220	100	11	......	20	13	13	11	68
11th week	235	115	12	1	5	14	18	12	62
12th week	235	115	1	9	15	13	14	19	71
13th week	235	115	6	4	10	7	8	5	50
Total	....	....	285	227	330	298	372	361	1,873
Feed eaten and gain	2,425	1,205	103	71	138	131	147	151	741

*B.—Barrow. †S.—Sow.

TABLE VII.—*Results of feeding whole corn, in comparison with corn meal, to fattening pigs.*

Lot. VI.—Fed corn meal, wheat middlings, and Dwarf Essex rape.

	FEED EATEN.		*B 333	B 326	B 321	B 230	†S 323	S 319	Total
	Corn meal.	Wheat mid-dlings.							
	Lbs	Lbs.	Lbs.	Lbs.	Lbs.	Lbs	Lbs.	Lbs.	Lbs.
Weight at beginning, July 3	....	....	167	196	203	201	193	183	1,143
Feed eaten and gain:									
1st week..................	100	50	8	10	17	10	13	7	65
2nd week..................	150	75	12	13	18	18	7	8	76
3rd week..................	150	75	8	14	5	3	10	9	49
4th week..................	150	75	4	9	8	10	6	5	42
5th week..................	150	75	15	15	12	13	11	10	76
6th week..................	200	100	6	4	7	10	10	13	50
7th week..................	200	100	14	14	13	15	10	8	74
8th week..................	200	100	17	17	14	17	11	10	86
9th week..................	200	100	1	13	15	13	16	12	70
10th week..................	220	110	12	10	4	3	9	5	43
11th week..................	235	115	17	14	19	20	4	8	82
12th week..................	235	115	16	17	14	7	16	17	87
13th week..................	235	115	9	15	23	21	24	17	109
Total weight	....	....	306	361	372	361	340	312	2,052
Feed eaten and gain	2,425	1,205	139	165	169	160	147	120	909

*B—Barrow. †S—Sow.

In the above trial, Lot V, fed shelled corn and wheat middlings, with access to rape pasture, gained 741 pounds, and consumed 3,630 pounds of grain, or 490 pounds of grain for 100 pounds of gain. As the table shows, sow 335 made poor gains. Although the lightest pig in the bunch, she was apparently in good, thrifty condition at the beginning of the experiment. As the feeding progressed, she was taken lame in her feet, her appetite was poor, and her weekly gains were correspondingly small. Had she gained proportionately with the others, the total gain of the lot would have been 63 pounds greater.

Lot VI, fed corn meal and wheat middlings, with access to rape pasture, gained 909 pounds, and consumed 3,630 pounds of grain, or 399 pounds of grain for 100 pounds of gain.

The lot getting corn meal consumed the same number of pounds of grain, but gained 168 pounds more than the shelled corn lot, producing a 100 pounds of grain on 91 pounds less feed than the lot getting shelled corn.

SUMMARY OF FEEDING TRIALS AT THIS STATION, COVERING A PERIOD OF TEN YEARS, IN WHICH ONE LOT OF FATTENING PIGS RECEIVED SHELLED CORN, AND ANOTHER CORN MEAL.

For the past ten years, this Station has been testing the value of feeding whole corn, in comparison with corn meal, as the main portion of the ration, for fattening pigs. During this period, eighteen trials have been made and the results published from year to year. The work of the past year, with a summary for the entire period, will complete the work of comparing whole corn with corn meal for fattening pigs, so far as this Station is concerned.

In this experiment it has been the aim to use sufficient animals and to extend the feeding trials through a series of years, in order to make the results reliable and reasonably conclusive. The 280 pigs used in this experiment belonged to various breeds, cross-breeds, and grades, as follows: Poland-China, 91; Berkshire, 52; Duroc-Jersey, 2; Yorkshire, 2; grade Poland-China, 2; grade Berkshire, 11; grade Chester White, 13; cross-

bred Poland-China-Berkshire, 65; cross-bred Poland-China-Chester White, 25; Razor-back, 6; cross-bred Poland-China-Razor-back, 5; cross-bred Berkshire-Razor-back, 6. The various breeds, cross-breeds, and grades were divided equally among the lots receiving shelled corn and the lots receiving corn meal.

The corn used in the experiment was, with one exception, over a year old. For six years corn was imported from Iowa. For three years old Wisconsin corn was used. During the last year, 1906, corn was secured near Madison, grown the same year. The results obtained with shelled corn cannot, therefore, be attributed to the use of soft corn.

The following table furnishes a summary of the trials from year to year and the totals and averages for the entire period.

TABLE VIII.—*Result of ten years' experiment in feeding shelled corn, in comparison with corn meal, to fattening pigs.*

Year.	Trial.	Lot receiving.	No. of pigs in experiment.	Average weight per head at beginning of experiment.	Length of feeding period.	Feed eaten.			Gains of lots.	Feed consumed per 100 pounds of gain for lots receiving:—		Economy of grinding expressed in per cent.	
						Shelled corn.	Corn meal.	Wheat middlings.		Shelled corn.	Corn meal.	Gained.	Lost.
				Lbs.	Days.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.		
1896	1	Shelled corn	9	354	70	5,314	....	633	1,235	481	....	....	....
		Corn meal	9	346	70	....	5,333	653	1,348	....	442	8.0	....
	2	Shelled corn	10	225	70	3,960	....	705	789	591	....	....	....
		Corn meal	10	223	70	....	4,537	699	1,076	....	487	17.6	....
1897	3	Shelled corn	9	212	84	3,284	....	1,642	984	501	....	....	....
		Corn meal	9	210	84	....	3,971	1,985	1,348	....	442	11.7	....
	4	Shelled corn	7	183	63	1,170	....	1,170	552	424	....	....	....
		Corn meal	7	198	63	....	1,330	1,330	576	....	462	....	8.9
1898	5	Shelled corn	8	184	84	2,758	....	1,379	830	500	....	....	....
		Corn meal	8	187	84	....	3,132	1,566	992	....	473	5.4	....
	6	Shelled corn	8	184	84	2,609	....	1,304	799	489	....	....	....
		Corn meal	8	184	84	....	3,078	1,539	1,030	....	448	8.3	....
1899	7	Shelled corn	19	186	84	7,084	....	3,542	2,136	497	....	....	....
		Corn meal	19	186	84	....	7,196	3,598	2,132	....	507	....	2.0
1900	8	Shelled corn	14	174	98	5,852	....	2,926	1,571	559	....	....	....
		Corn meal	14	175	98	....	6,183	3,092	1,938	....	479	14.3	....

1901	9	Shelled corn	12	145	84	3,504		1,752	893	588			
		Corn meal	12	148	84		3,831	1,914	1,038		553	6.0	
1902	10	Shelled corn	3	70	84	519		519	234	444			
		Corn meal	3	72	84		489	489	218		449		1.1
	11	Shel'ed corn	3	80	84	452		452	169	594			
		Corn meal	3	80	84		480	480	166		579	2.5	
	12	Shelled corn	3	133	91	713		713	255	559			
		Corn meal	3	134	91		703	703	274		513	8.2	
1904	13	Shelled corn	4	126	70	1,139			208	548			
		Corn meal	4	127	70		1,408		246		572		4.3
	14	Shelled corn	3	83	70	443			60	738			
		Corn meal	3	84	70		582		71		820		11.1
1905	15	Shelled corn	5	139	98	1,616		1,617	618	523			
		Corn meal	5	145	98		1,530	1,530	530		577		10.3
1906	16	Shelled corn	12	68	84	*2,169		2,168	1,205	360			
		Corn meal	12	68	84		*2,373	2,373	1,298		366		1.6
	17	Shelled corn	5	184	84	1,725		863	549	471			
		Corn meal	5	175	84		2,066	1,033	701		442	6.1	
	18	Shelled corn	6	189	91	2,425		1,205	741	490			
		Corn meal	6	190	91		2,425	1,205	909		399	18.5	
Totals...		Shelled corn	140			46,736		22,510	13,828				
		Corn meal	140				50,617	24,189	15,891				
Averages		Shelled corn	8	175	82	2,596		1,255	768	501			
		Corn meal	8	175	82		2,813	1,344	883		471	6.0	

* Fed 2,009 pounds of skim milk in addition to grain ration.

The table shows that, in the ten years covered by the experiment, eighteen trials were made with a total of 280 pigs, one-half of this number receiving shelled corn as the principal portion of the ration, and the other half corn meal.

The feed required to produce 100 pounds of gain varied from 360 to 820 pounds. The poorest gains for feed consumed were made in Trial 14 where corn alone was fed to young pigs averaging 84 pounds in weight at the beginning of the trial. This emphasizes what is a common experience among hog raisers, that an exclusive diet of corn is not desirable with any class of hogs and is especially to be avoided with young pigs. The evil effects of this kind of a ration were shown in the decreased thrift, appetite, and gains, and in the large amount of feed required to produce a 100 pounds of gain.

The best gains for feed consumed were made with young pigs receiving shelled corn as the principal ration ate 46,736 weight, of corn and middlings, was supplemented with a small allowance of skim milk. The pig feeder is warranted, not only in using a variety of grains, but will find it to his advantage to add skim milk to the ration whenever he can get it.

The totals and averages for the ten years show that the 140 pigs receiving shelled corn as the principal ration ate 46,736 pounds of shelled corn and 22,590 pounds of wheat middlings, or a total of 69,326 pounds of grain, on which they made 13,828 pounds of gain.

The 140 pigs receiving corn meal as the principal ration ate 50,647 pounds of corn meal and 24,189 pounds of wheat middlings, or a total of 74,836 pounds of grain, on which they made 15,891 pounds of gain.

The 140 pigs receiving the corn meal ate 5,510 pounds more grain and made 2,036 pounds more gain than the 140 pigs receiving shelled corn.

The pigs receiving the shelled corn consumed an average of 501 pounds of grain for each 100 pounds of gain.

The pigs receiving the corn meal consumed an average of 471 pounds of grain per 100 pounds of gain, thus producing 100 pounds of gain on 30 pounds less grain than the pigs receiving shelled corn.

In the eighteen trials there were eleven which showed a saving by grinding, the amount saved varying from 2.5 per cent in Trial 11, to 18.5 per cent in Trial 18. There were seven trials where there was a loss from grinding, the amount lost varying from 1.1 per cent, in Trial 10, to 11.1 per cent in Trial 14.

The average of the eighteen trials shows a saving from grinding corn of 6 per cent.

By taking the average gain per pig of both lots in each trial and counting the number of pigs that gained more than the average, and those gaining less than the average, it was found that, with the lots receiving shelled corn as its principal ration, there were 45 pigs that gained more than the average, and 95 pigs that fell below the average.

With the lots receiving corn meal as its principal ration there were 91 pigs that gained more than the average, and 49 that fell below the average.

The economy of grinding corn will depend on the price of corn and the cost of grinding. With an average saving of 6 per cent by grinding corn, the following table is constructed to assist the farmer in determining when to grind.

The table shows that when corn is worth 25 cents per bushel

TABLE IX.—*Saving effected per bushel by grinding corn for fattening pigs.*

	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
When corn is worth	25	30	35	40	45	50	55	60	65	70	75
Saved by grinding..	1.5	1.8	2.1	2.4	2.7	3 0	3.3	3.6	3.9	4.2	4.5

the saving from grinding is only 1.5 cents, not enough to cover the cost unless cheap power is available. As corn advances in price the saving per bushel increases three-tenths of a cent with each five cents' advance. With corn at 75 cents per bushel, the saving from grinding is 4.5 cents per bushel.

Where there is plenty of time for maturing the pigs, and it is not necessary to secure the maxium daily gain, it is doubtful if it pays to grind corn for pigs.

The test shows that where quick maturity is an important item, better results are secured from the corn meal. Pigs fed corn meal, eat more grain and make somewhat larger daily gains.

Corn meal can doubtless be used to good advantage in finishing off a bunch of hogs which were at first fed shelled corn. Changing over to corn meal near the close of the feeding period also furnishes a change in the character of the ration, which will be satisfactory to the animals.

There are conditions and circumstances where it is not advisable to grind the corn even though the corn be high priced. On the other hand, when fitting hogs for show, sale, or in high pressure feeding for market, the feeder will consider it advisable to grind the corn, even though it is expensive to do so. The feeder, knowing these results, will use them to suit his own conditions.

SOY BEAN MEAL VERSUS WHEAT MIDDLINGS AS A SUPPLEMENT TO CORN MEAL FOR GROWING AND FATTENING PIGS.

GEO. C. HUMPHREY AND J. G. FULLER.

This article is a report of the third trial conducted to compare the value of soy bean meal and wheat middlings as a supplement to corn meal for growing and fattening pigs. Experience has taught that corn alone is not a good ration for pigs; it must be supplemented by one or more feeds of a different character which will form a balanced ration. Wheat middlings are generally recognized as being an excellent supplement to corn meal in preparing a ration for growing and fattening pigs; soy beans, being rich in protein and fat, are said to be equally as good. The results of these three trials will be summarized in the conclusion of this article.

OUTLINE OF THIRD TRIAL.

Ten pigs, from early spring litters, were divided into two lots as nearly uniform as possible. Each lot contained three Duroc-Jerseys and two Tamworths, all pure-breds and of good quality. The trial commenced July 13, 1905, after the lots had been placed in rape paddocks and were accustomed to their quarters. In addition to rape pasture, to which both lots had access during the first twelve weeks, Lot I was given a grain ration of two parts by weight of corn meal and one part soy bean meal, and Lot II, two parts corn meal and one part wheat

middlings; skim milk was fed in addition to the grain during the entire trial. With the exception of the first six weeks, the grain of both lots was mixed with an equal amount of skim milk and fed in the form of a thick slop. In addition to this both lots received fresh water, salt, and ashes *ad libitum*.

TABLE I.—*Feed consumed and gains made by pigs on rape pasture, fed soy bean meal versus wheat middlings as a supplement to corn meal.*

	Lot I. Fed a grain ration of corn meal and soy beans.					Lot II. Fed a grain ration of corn meal and wheat middlings.				
	Corn and soy beans.	Skim milk.	Gain.	Average gain per head per day.	Grain consumed per pound of gain.	Corn and middlings.	Skim milk.	Gain.	Average gain per head per day.	Grain consumed per pound of gain.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Initial weight	.....	.....	*459	.....	.....	.....	.....	*452	.....	.....
1st two weeks	140	168	56	.80	2.50	140	168	73	1.04	1.92
2nd two weeks	140	168	65	.93	2.15	140	168	60	.86	2.33
3rd two weeks	140	168	49	.70	2.85	1 0	168	45	.64	3.11
4th two weeks	168	168	51	.73	3.30	168	168	50	.71	3.36
5th two weeks	168	168	64	.91	2.63	168	168	55	.79	3.06
6th two weeks	182	182	21	.30	8.67	182	182	25	.36	7.28
Final weight	.....	.....	765	.....	.....	.....	.....	760	.....	.....
Total feed and gain	938	1,022	306	†.75	†2.96	938	1,022	308	†.73	†3 05

*Weight of five pigs. †Average for period.

Summary and average for twelve weeks.

	Lot I. Fed corn, soy bean meal and rape pasture.	Lot II. Fed corn meal, middlings and rape pasture
	Lbs.	Lbs.
Total gain for period	306	308
Daily gain per head	.75	.73
Grain consumed per head daily	2.23	2.23
Skim milk consumed per head daily	2.43	2.43
Grain consumed per pound of gain	3.06	3.05
Skim milk consumed per pound of gain	3.34	3.35

The entire trial covered a period of twenty-four weeks during twelve of which the pigs had the benefit of the rape pasture, and during the remaining twelve they were confined in pens, and received only grain and skim milk. The results for the two twelve-week periods are reported separately. The fol-

lowing table gives the amounts of grain and skim milk consumed and the gains made during the time the pigs were on rape.

From the foregoing table it will be noticed that Lot I, fed corn meal and wheat middlings, made two pounds better gain. Plenty of exercise, with the rape pasture tended to make both lots grow, rather than lay on fat, although the pigs were in fair flesh at the close of this period. From the summary of Table I it will be noted that the amount of grain consumed per pound of gain was comparatively small when we consider that the supply of rape was nearly exhausted when the pigs were removed to the barn. The gains for both lots during the last two weeks were low, and indicate that the pigs should have been removed to the barn two weeks earlier.

At the hog barn the ration of grain and skim milk was increased as fast as both lots would consume the feed without waste. For some unknown cause, Lot I did not feed well the first two weeks and the gains made were low. The following table shows the amount of feed consumed and the gains made during the time the pigs were confined in pens.

TABLE II.—*Feed consumed and gains made by pigs, confined in pens, and fed soy bean meal versus wheat middlings as a supplement to corn meal.*

	Lot I. Fed corn meal and soy bean meal.					Lot II. Fed corn meal and wheat middlings.				
	Corn and soy beans.	Skim milk.	Gain.	Average gain per head per day.	Grain consumed per pound of gain.	Corn and middlings.	Skim milk.	Gain.	Average gain per head per day.	Grain consumed per pound of gain.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Initial weight	.....	....	*765	.....	....	.....	....	*760	...	..
1st two weeks	220	220	30	.43	7.33	220	220	70	1.00	3.14
2nd two weeks	252	252	80	1.14	3.15	252	252	55	.81	3.11
3rd two weeks	336	336	115	1.64	2.92	336	336	115	1.64	2.92
4th two weeks	364	364	105	1.50	3.47	364	364	77	1.10	4.73
5th two weeks	392	392	127	1.81	3.09	392	392	95	1.36	4.13
6th two weeks	420	420	98	1.40	4.29	420	420	103	1.47	4.08
Final weight	......	......	1,320	......	......	......	......	1,275	......	......
Total feed and gain	1,984	1,984	555	†1.32	†3.57	1,984	1,984	515	†1.23	†3.85

*Weight of five pigs. †Average for period.

Summary and average for twelve weeks.

	Lot I. Fed corn meal and soy be n	Lot II. Fed corn meal and wheat middlings.
	Lbs.	Lbs.
Total gain for period	555	515
Daily gain per head	1.32	1.23
Grain consumed per head	4.72	4.72
Skim milk consumed per head daily	4.72	4.72
Grain consumed per pound of gain	3.57	3.85
Skim milk consumed per pound of gain	3.57	3.85
Dry matter consumed per head daily	4.66	4.61
Dry matter consumed per pound of gain	3.53	3.75
Digestible protein consumed per head daily	.81	.56
Digestible protein consumed per pound of gain	.61	.46
Digestible carbohydrates and fat consumed per head daily	3.48	3.59
Digestible carbohydrates and fat consumed per pound of gain	3.53	3.75
Nutritive ratio of average dai y ration 1:	4.3	6.4

In comparing the results given in the above table, it will be noted that Lot I, fed corn meal and soy bean meal, gained 555 pounds, and Lot II, fed corn meal and wheat middlings, 515 pounds, a difference of 40 pounds in favor of Lot I,in spite of the low gain made by this lot during the first two weeks. The feed consumed by the two lots being the same, it follows that Lot I made the more economical gains. Lot I required 3.57 pounds of grain and 3.57 pounds of skim milk for each pound of gain, while Lot II required 3.85 pounds of grain and 3.85 pounds of skim milk, making a difference, for each 100 pounds of gain, of 28 pounds of grain and 28 pounds of skim milk in favor of the soy bean meal. If we assume that the grain fed the two lots was worth $20 a ton and the skim milk 20 cents per hundred weight, the lot getting corn meal and soy bean meal produced pork at nearly 33 cents per hundred pounds cheaper than did the lot getting corn and middlings. On the basis of the gains made during the last twelve-week period, the value of soy beans is about 8 per cent greater than the value of wheat middlings for balancing a corn ration for pigs.

DISCUSSION OF RATIONS FED.

The following table gives the composition of the feeding stuffs and the per cent of the digestible nutrients in the rations fed a year ago. It is repeated here for the purpose of giving

some idea as to the composition and nutrients contained in the rations fed this year, which were practically the same as those fed the year previous. The composition of the wheat middlings and skim milk, and the digestible nutrients of the several feeding stuffs were calculated from tables from Henry's "Feeds and Feeding." The analyses of the corn and soy beans were made by Assistant Chemist, Geo. A. Olson of this Station.

TABLE III.—*Composition of feeding stuffs used in testing the value of soy bean meal versus wheat middlings as a supplement to corn meal for growing and fattening pigs.*

Total nutrients.	Corn meal.	Wheat middlings.	Soy beans.	Skim milk.
	Per cent.	Per cent.	Per cent.	Per cent.
Moisture	11.76	12.10	8.96	90.60
Ether extract	3.86	4.00	17.50	0.30
Protein	9.38	15.60	33.81	3.10
Crude fiber	1.26	4.60	4.77	....
Nitrogen free extract	72.31	60.40	27.97	5.30
Ash	1.43	3.30	6.99	0.70
Digestible nutrients:				
Dry matter	88.24	87.90	91.04	9.40
Protein	7.12	12.80	29.41	2.90
Carbohydrates and fat	75.28	60.40	53.08	5.86
Nutritive ratio 1:	10.6	4.7	1.8	2.0

From Table III it will be noted that the amount of digestible protein in soy beans is nearly four times as great as that in the corn and twice as great as that in the wheat middlings, while the digestible fat in the soy beans is four times as great as that in the middlings and the corn meal, respectively. Corn meal contains nearly three and one-half times as much digestible carbohydrates as soy beans, and wheat middlings contain nearly three times as much as soy beans.

In the summary for Table II it will be noted that the amount of feed consumed per head daily was the same for both lots. The amount of dry matter consumed per head daily was, however, 4.66 pounds for Lot I, and 4.61 pounds for Lot II. This difference is due to the greater amount of dry matter contained in the soy beans. The amount of digestible protein consumed by the pigs of Lot I is considerably greater than

that consumed by Lot II, the amounts consumed per head daily for the two lots being .81 and .56 of a pound, respectively. The nutritive ratio of the average daily ration for Lot I was 1:4.3 and for Lot II 1:6.4. The difference in the amount of protein consumed by the two lots is not in proportion to the difference in the gains made; neither can it be said that the greater gain made by Lot I is in proportion to the greater amount of digestible fat contained in the soy beans. If there is any one factor which accounts for the greater gain made by Lot I it is the difference in the dry matter contained in the ration of corn and soy beans. However, the results of this experiment do not warrant a definite conclusion on this point.

CARCASS TEST.

One Duroc-Jersey and one Tamworth were taken from each lot at the close of the trial and killed for the purpose of noting the influence of the rations upon the carcass. The following table gives the weights of the carcasses and various organs of the pigs when slaughtered.

TABLE IV.—*Weights of carcasses and various organs of pigs slaughtered.*

	Lot I. Fed corn meal and soy bean meal.		Lot II. Fed corn meal and wheat middlings.	
	Tamworth.	Duroc-Jersey.	Tamworth.	Duroc-Jersey.
	Lbs.	Lbs.	Lbs.	Lbs.
Live weight prior to sl'ghtering...	214	206	214	176
Dressed weight	149.4	151.0	156	121.5
Per cent. of dressed weight	69 8	73.3	72.4	70.1
Weight of blood	7.2	5.9	6.7	5.0
Weight of liver	3.7	4.2	4.7	2.8
Weight of tongue	.7	.8	.5	.7
Weight of heart	.8	.8	.8	.7
Weight of spleen	.5	.4	.5	.4
Weight of gall.	.2	.2	.2	3
Weight of lungs	3.5	2.4	3.6	1.9
Weight of stomach	2.3	1.8	2.6	1.4
Weight of bladder	.3	.2	.4	.2
Weight of kidneys	.6	.8	.8	.6
Weight of kidney fat	6.8	7.1	4.3	6.9
Weight of intestinal fat	2.2	2.4	2.3	2.7
Weight of large intestines	11.5	10.2	12.0	9.5
Weight of small intestines	5.1	6.2	8 2	4.6
Length of intestines	85 ft.	92 ft.	86.6 ft.	62.6 ft.

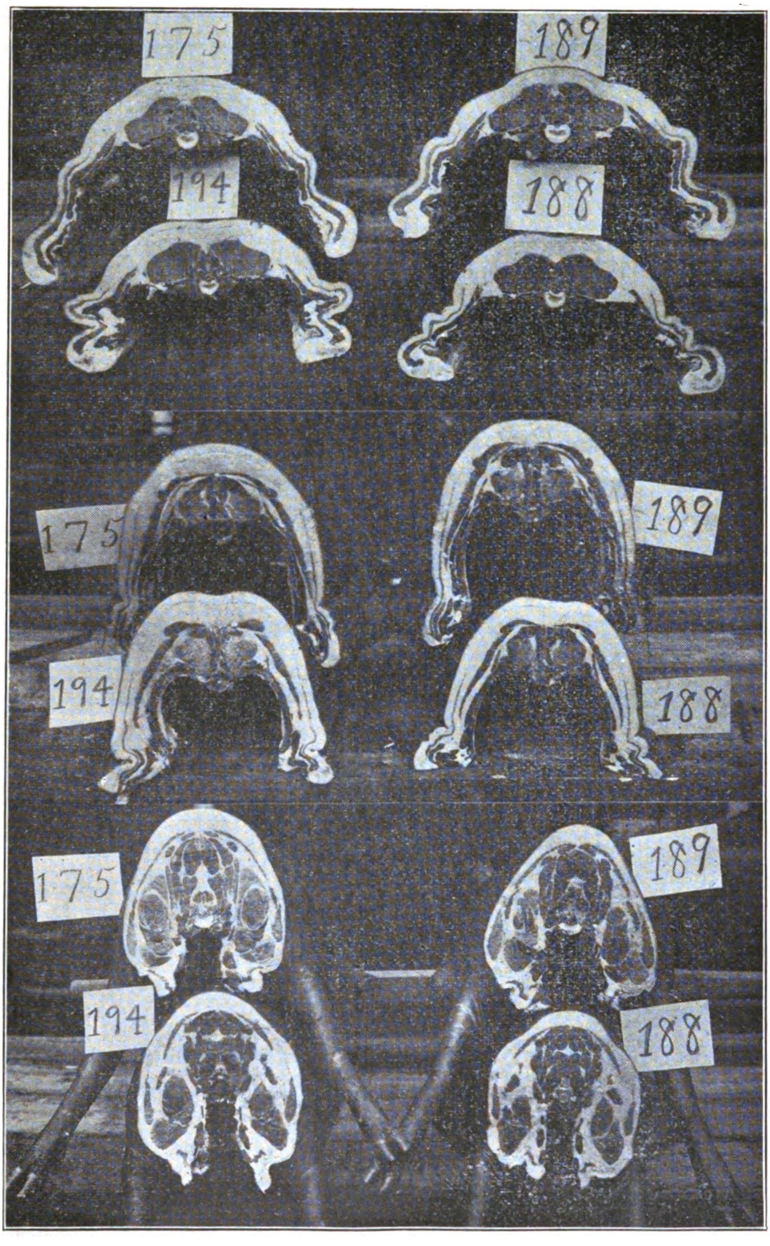


Fig. 1.—Cross-sections showing distribution of fat and lean; 175 Tamworth, 194 Duroc-Jersey, fed corn meal and soy bean meal; 189 Tamworth, 188 Duroc-Jersey, fed corn meal and wheat middlings.

TABLE IV.—*Summary of slaughter test*—Continued.

	* Lot I. Fed corn meal and soy bean meal.	* Lot II. Fed corn meal and wheat middlings.
	Lbs.	Lbs.
Shrinkage, 12 hours off feed	15	14
Total live weight when killed	420	390
Total dressed weight	300.4	277.5
	Per cent.	Per cent.
Dressed weight	71.0	71.1
Blood	3.1	3.0
Tongues, livers, and hearts	2.6	2.6
Entire offal not including fat and blood	13.6	14.6
Intestinal fat	1.1	1.3
Kidney fat	3.3	2.9

* Two pigs only.

In the summary of the slaughter test the per cent of dressed carcass for the two lots is practically the same. In the former trials the per cent of dressed carcasses was in favor of Lot II, fed corn meal and wheat middlings, and the same obtains in a slight manner, in this third trial. In the two previous trials there was a greater percentage in weight of tongues, hearts and livers, and offal, not including the intestinal fat and blood, and a greater length of the intestines for the pigs of Lot I, fed corn meal and soy bean meal. In the third trial there is a difference in the length of the intestines, those for two pigs tested in Lot I being 27.8 feet longer than those for two pigs of Lot II. This difference is a matter of interest, but one is not justified, at this time, in attributing it to soy beans.

The carcasses were cut in a manner to show the muscle and fat development, and may be studied from the accompanying cut. Nos. 175 and 194 represent the carcasses of Lot I, fed corn meal and soy bean meal. In the third trial there is a dif-casses of Lot II, fed corn meal and wheat middlings. Nos. 175 and 189 are Tamworths and 188 and 194 are Duroc-Jerseys. The cuts were made in front of the shoulders, between the fifth and sixth ribs, and across the loins.

The first difference noted in handling the carcasses was the soft and flabby condition of Lot I, fed corn meal and soy bean meal, and the firmness of flesh of Lot II, fed corn meal and wheat middlings.

The amount of meat in the carcasses of Lot I, fed corn meal and soy bean meal, did not appear to be much greater, if any, than that in the carcasses of Lot II, fed corn meal and wheat middlings. The muscular flesh of the latter, however, was of a bright cherry red with a fine grain, which, together with its firmness and nicely marbled condition, made it better quality of pork for the block. The flesh of the former lot was pale red, and the fat was not so well mingled with the lean, but seemed to be deposited beneath the skin in a superficial manner. From all that could be judged from viewing the cuts with the naked eye, the ration of corn meal and wheat middlings was superior to that of corn meal and soy bean meal for producing a good quality of pork.

SUMMARY.

Soy bean meal makes an excellent supplement to corn meal for growing and fattening pigs.

Soy bean meal is from 8 to 10 per cent more valuable than wheat middlings for economical pork production when the cost of the two feeds is the same.

Soy bean meal mixed with corn meal in the porportion of 1:2, produces greater gains than wheat middlings and corn meal fed in the same proportion.

In feeding equal amounts of the two rations, soy beans and corn meal supply a slightly higher per cent of dry matter and digestible matter than wheat middlings and corn meal.

For firmness, fine grain and texture of flesh, and even distribution of fat and lean, the ration of wheat middlings and corn meal is superior to that of soy beans and corn meal.

PORTABLE HOG HOUSES

JAS. G. FULLER.

At the University piggery various methods of housing swine are in use. A large hog house including feed room, scales, etc., has been in use for several years. As enlarged facilities became necessary, we have used small houses, commonly known as cots.

The first type of cot used is represented in Fig. I and is constructed in the following manner:—The frame work, as the cut shows, is made by using 2x4's 16 feet long, sawed in the middle, thus making the bottom dimension 8 feet square, each side 8 feet square, the gable ends being thus formed with rafters 8 feet in length. The front sill is laid flat-wise to interfere as little as possible with the young pigs going in and out. The frame rests on short pieces of 2x4's railed across each corner, which can be replaced when necessary. When a floor is desired it should be constructed on stringers and the frame made to rest thereon The following lumber will build the house without floor.

13	pieces No. 1,	1 inch x 12 inches,	16 feet long,
6	pieces	2 inches x 4 inches,	16 feet long,
10	O. G. battens,		16 feet long.

Eight boards, sawed in the middle, make the sides and the remainder, the ends. A small perpendicular slide window is usually made in the rear gable for ventilation. The total cost of material for the house, as shown in the cut, without floor, amounts to practically $11.00.

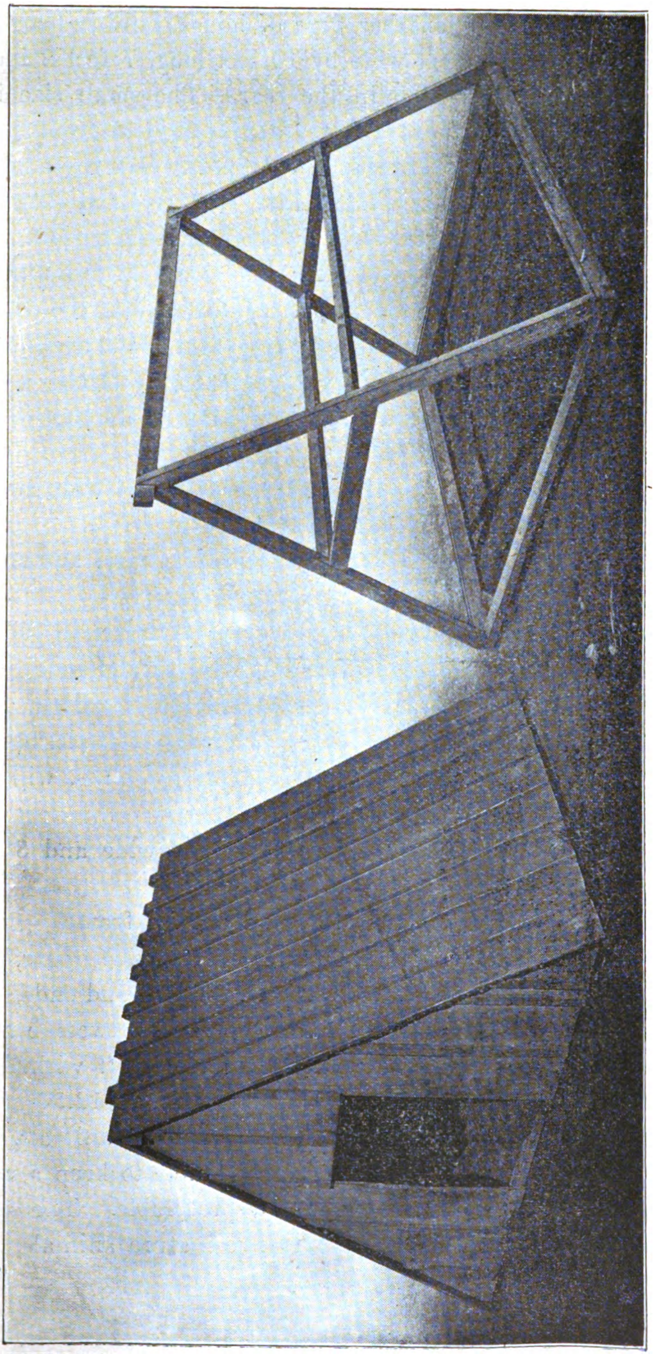


Fig. 2.—Frame work for "wigwam cot," and front view of cot completed.

In Fig. 3 we show another type of house, built in two sizes. The large house is 8 feet wide by 10 feet long, 7 feet 2 inches high in front, 3 feet high in the rear. The small size is 6 feet wide and 8 feet long, 6 feet 2 inches high in front and 3 feet high in the rear. The cut shows plainly how these houses are constructed; the floor is built first, with 2x4's as stringers, and the frame is held on the floor by blocks at each corner. The large sized house is provided with two doors in front and a temporary movable partition in the middle so that the cot can easily be adjusted to accommodate two lots of swine at the same time. On a level with the glass windows, there is also a drop window, preferably hung on hinges, fastened at the top for ventilation and sunlight.

The lumber required for the large house, 8 feet wide and 10 feet long, including floor, is as follows:

20 pieces 2 inches x 4 inches, 10 feet long for frame and stringers,
2 pieces 2 inches x 4 inches, 16 feet long for frame in ends,
20 pieces 1 inch x12 inches, 16 feet long for roof and ends,
5 pieces 1 inch x12 inches, 16 feet long (rough) for floor,
15 O. G. battens, 16 feet long for sealing cracks between boards.

The material, including the door, hinges and glass, will cost between $16.00 and $17.00.

The lumber required for the house 6 feet wide and 8 feet long is as follows:

12 pieces 2 inches x 4 inches, 16 feet long, for frame,
4 pieces 1 inch x12 inches, 16 feet long (rough), for floor,
13 pieces 1 inch x12 inches, 16 feet long, for roof and ends,
10 O. G. battens, 16 feet long for sealing cracks between boards.

The total cost of material to build the small cot with floor, door, and window complete, amounts to about $12.50. For neatness, economy, durability, and comfort to the animals, this type of cot is excellent. Where it is desirable to keep a number of hogs in one lot the large size is preferable. The small cot will accommodate from three to five mature animals, and the large cot, from seven to nine.

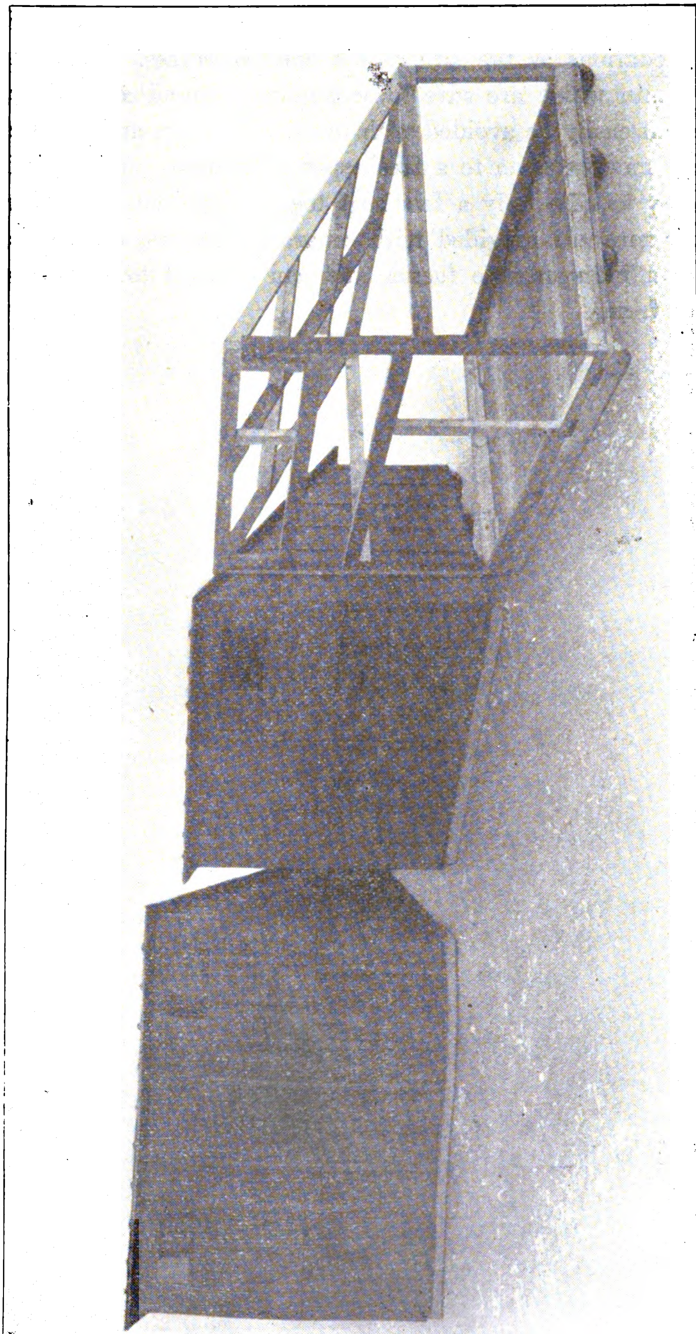


Fig. 3.—Frame work and cots completed. The large size 8 feet by 10 feet, and the small size 6 feet by 9 feet.

With the cot system the farmer, or breeder, can enlarge his accommodations as the size of his herd increases. The mud and vermin which are sure to accumulate around a large hog house can easily be avoided with the small houses and by occasionally moving them to a fresh spot of ground. Where it is necessary to keep only a few hogs together, or where several animals must be provided with separate quarters, the cot becomes an indispensable factor, and can be used to advantage on any farm.

THE PRODUCTION OF WINTER LAMBS.

GEORGE C. HUMPREY AND FRANK KLEINHEINZ.

The first attempt to produce winter lambs at this Station is recorded in the Twenty-Second Annual Report. The trial, although successful, will be repeated for a period of years so that definite conclusions may be drawn from the experiment.

We wish to correct a statement in the Twenty-Second Annual Report in regard to the grain ration fed; instead of twenty parts bran, ten parts oats, and one part oil meal, as stated, the feed consisted of twenty parts oats, ten parts bran, and one part oil meal.

OUTLINE OF SECOND TRIAL.

Six ewes, two grade Dorsets, two grade Shropshires, one pure-bred Hampshire, and one pure-bred Southdown were turned with a pure-bred Southdown ram on July 12. All had been on grass pasture since early spring and were in good condition. About one and one-half pounds of bran and oats were fed daily to the six ewes and ram during the months of July and August when the pastures became dry and short. Each ewe, from late in November, when put into the barn, until the time the lambs were dropped, was given a daily ration of about one-half pound of bran and whole oats, mixed in equal parts by weight, clover hay, and a little corn silage.

The year before no difficulty was experienced in getting one of the above grade Shropshire ewes to breed early enough to produce a winter lamb. The ewes included in this trial had weaned their lambs early in the spring and were in splendid

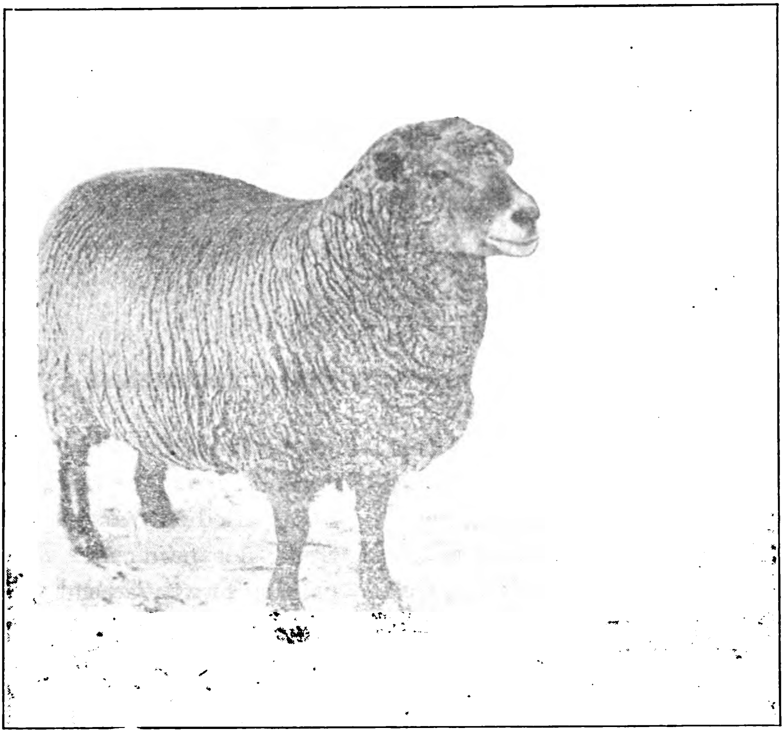


Fig. 4.—Pure-bred Southdown ram which sired winter lambs.

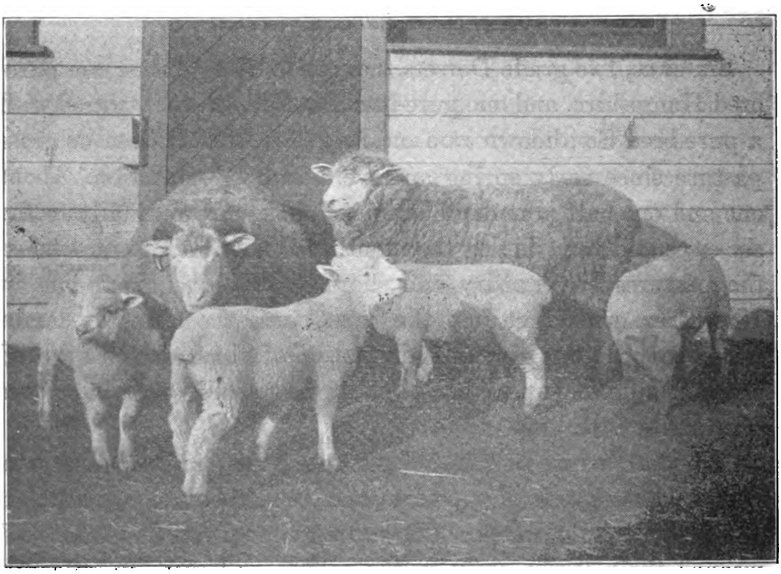


Fig. 5.—Two grade Dorset ewes and their four winter lambs.

condition, but only the two grade Dorset ewes bred early enough to produce winter lambs. This emphasizes the fact that only grade or pure-bred Dorset ewes can be depended upon for producing winter lambs.

The following table gives a description of the two grade Dorset ewes and the Southdown ram, their condition at time of breeding, their weight at the beginning and end of the trial, and the milking quality of the ewes.

TABLE I.—*Description of ewes and ram which produced winter lambs.*

SHEEP.	Ear tag number.	Age.	Date when bred.	Condition when bred.	Weight at beginning of trial.	Weight at end of trial.	Gain.	Milking quality.
		Yrs.						
Grade Dorset...........	67	5	July 18	Very good..	181	181	8	Fair.
Grade Dorset. . ..	235	4	July 20	Very good	171	179	8	Very good.
*Pure-bred Southdown.	16328	3	....	Very good	†186	.....	......	....

*Ram. †Weight at time of service.

MANAGEMENT OF EWES AND LAMBS.

Careful provision was made to have the ewes in the lambing pens in due season for lambing. In order to save the lambs and insure a rapid growth, the pens were warmed during cold weather by a stove in an adjacent room.

The following table gives a description of the lambs when dropped:—

TABLE II.—*Date of birth and description of winter lambs.*

Lamb.	When dropped.	Dam.	Sex.	Weight at birth.	Condition at birth.
No. 553	Dec 14, 1905	67	Ram.....	10.6	Strong.
No. 554	Dec 14, 1905	67	Ewe	8.3	Strong.
No. 555	Dec. 15, 1905	235	Ram.. ...	8.9	Strong.
No 556	Dec. 15, 1905	235	Ewe	6.9	Strong.

During the trial the ewes were fed twice daily a grain mixture containing twenty parts oats, ten parts bran, and one part oil meal, by weight. Their roughage consisted of alfalfa hay and corn silage.

On January 5, the lambs were old enough to withstand a cooler temperature, and were transferred, with the ewes, to the regular sheep barn. A lamb crib was provided where the lambs had access to fresh grain and alfalfa hay. The grain fed the lambs was a mixture of four parts bran, two parts oats, two parts corn meal, and one part oil meal, by weight.

Unfortunately, the feed consumed by the ewes from the time the lambs were dropped until January 5, had to be estimated. The ewes were fed a very small amount of grain and silage for the first three days which was gradually increased until they were on full feed, which required from two to three weeks. The following tables show the amounts of feed consumed by the ewes and lambs during the trial:—

TABLE III.—*Feed account for ewes which produced winter lambs.*

DATE.	Ewes in lot.	*Hay.	Silage.	Total roughage.	Total grain	Cost of feed.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Dec. 14 to Jan 5	2	84.8	90.2	175.0	56.6	$ .99
Jan. 5 to 12	2	36.6	57.7	94.3	36.2	.54
Jan. 12 to 19	2	33.6	66.2	99.8	40.0	.57
Jan. 19 to 26	2	32.3	64.7	97.0	34.2	.52
Jan. 26 to Feb 2	2	32.2	70.3	102.5	35.0	.53
Feb. 2 to 9	2	39.5	74.5	114.0	35.6	.58
Feb. 9 to 12	2	17.0	26.7	43.7	17.6	.25
Total	....	276.0	450.3	726.3	255.2	3.98

* Alfalfa.

TABLE IV.—*Feed account for winter lambs.*

DATE.	Lambs in lot.	*Hay.	Grain.	AVERAGE AMOUNT PER HEAD.		Cost of feed.
				Hay.	Grain.	
		Lbs.	Lbs.	Lbs.	Lbs.	
Jan. 5 to 12	4	.2	1.1	.05	.28	.01
Jan. 12 to 19	4	5 5	8.7	1.38	2.18	.10
Jan. 19 to 26	4	6.0	10.8	1.50	2 70	.12
Jan. 26 to Feb. 2	4	9.5	10.6	2.38	2.65	.13
Feb. 2 to Feb. 9	4	16.0	13.3	4.00	3.33	.19
Feb. 9 to 12	4	9.6	6.7	2.15	1.68	.10
Total and average	.. ..	46.8	51.2	11.70	12.80	.65

* Alfalfa.

TABLE V.—*Amount and cost of feed for ewes and winter lambs.*

Date.	Ewes in lot.	Lambs in lot.	Feed for ewes.			Feed for lambs.			Total f'd.		Total cost.
			Roughage.	Grain.	Cost.	Roughage.	Grain.	Cost.	Roughage.	Grain.	
			Lbs.	Lbs.		Lbs.	Lbs.		Lbs.	Lbs.	
Dec. 14 to Jan. 5..	2	......	175.0	56.6	$.99	....	......	....	175.0	56.6	$.99
Jan. 5 to 12.......	2	4	94.3	36.2	.54	.2	1.1	$ .01	94.5	37.3	.55
Jan. 12 to 19	2	4	99.8	40.0	.57	5.5	8.7	.10	105.3	48.7	.67
Jan. 19 to 26 ...	2	4	97.0	34.2	.52	6.0	10.8	.12	103.0	45.0	.64
Jan. 26 to Feb. 2..	2	4	102.5	35.0	.53	9.5	10.6	.13	112.0	45.6	.66
Feb. 2 to 9........	2	4	114.0	35.6	.58	16.0	13.3	.19	130.0	48.9	.77
Feb. 9 to 12.	2	4	43.7	17.6	.25	9.6	6.7	.10	53.3	24.3	.35
Total	......	......	726.3	255.2	$3.98	46.8	51.2	$.65	773.1	306.4	$4.63

Fig. 6.—Four lambs marketed February 13, 1906. Average live weight 41.7 pounds.

Unfortunately, cabbage and roots were not available for the ewes. To secure the best gains with winter lambs, the ration for the ewes should be planned with the idea of encouraging as large a flow of milk as possible. The lambs ate more or less of the grain and hay supplied the ewes in addition to what was charged to them in Table IV. The following table gives the weights and gains made by the lambs during the trial:—

TABLE VI.—*Weights and gains of winter lambs.*

DATE.	No. 553.		No. 554.		No. 555.		No. 556.		Total gain.	Average gain per head.
	Weight.	Gain.	Weight.	Gain.	Weight.	Gain.	Weight.	Gain.		
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Initial weight*,	10.6	......	8.3	......	8.9	..	6.9	....	.....	......
Jan. 5	23.5	12.9	19.5	11.2	20.0	11.1	18.5	11.6	46.8	11.7
Jan. 12	26.0	2.5	23.5	4.0	23.0	3.0	23 0	4.5	14.0	3.5
Jan. 19	29.0	3.0	25.0	1.5	28.0	5 0	27.0	4.0	13.5	3.4
Jan. 26	33.0	4.0	27.0	2.0	33.0	5.0	31.5	4.5	15.5	3 9
Feb. 2	37.0	4.0	31.0	4 0	39.0	6.0	34.5	3.0	17.0	4.3
Feb. 9	42.0	5.0	36.5	5.5	43.0	4.0	38.0	3 5	18.0	4.5
Feb. 12	44.5	2.5	38.5	2.0	44.5	1.5	39.5	1.5	7.5	1.9
Total and average.	......	33.9	......	30.2	.....	35.6	......	32.6	132.3	33.1

*Weight for 553 and 554 Dec. 14, 1905, and for 555 and 556 Dec. 15, 1905.

The lambs were docked when about ten days old, and Nos. 553 and 555 were castrated a few days later. Apparently these operations did not affect the lambs much, and, where good, warm, clean pens are provided, are believed to add to the final results. Throughout the trial the lambs made good gains, and none were off-feed nor subject to scours.

MARKETING THE LAMBS.

A year ago seven lambs were expressed alive to Clay, Robinson & Co., Chicago. This necessitated an expense of $2.50 for crates and $5.50 for express charges, which reduced the profits considerably. This year four lambs were purchased by the Saddle and Sirloin Club, Union Stock Yards, Chicago, and were slaughtered and neatly dressed by an expert butcher before shipment. The cost of killing and dressing the lambs was nearly offset by the price received for the pelts. The express charges amounted to only 92 cents, and the crate to $1.00, which made the cost much lower than it would have been had the lambs been marketed alive. The carcasses were first allowed to cool, and then wrapped with one thickness of cheese cloth and one thickness of paper, after which they were packed into one crate. The photographs from which the accompanying cuts were made were taken after the carcasses arrived in Chi-

cago. The condition and attractiveness of the carcasses were reported as satisfactory, and brought $9.00 a piece, an excellent price for lambs whose average age was only fifty-nine days.

The following financial statement shows the cost of producing the lambs, and the net profits. The cost of keeping the ewes during the remaining portion of the year is fully offset by their wool clip, which, for the two ewes, this season, amounted to 12.5 pounds.

The following schedule of prices was used in calculating the cost of the feeds used in this trial:—

PRICES OF FEEDS.

Alfalfa hay, per hundred pounds	$0 50
Silage, per hundred pounds	12½
Oats, per hundred pounds	80
Corn, per hundred pounds	70
Bran, per hundred pounds	75
Oil meal, per hundred pounds	1 20

TABLE VII.—*Financial statement for production of winter lambs.*

1906.	Dr.	
Feb. 12	To feed for two ewes	$3 95
Feb. 12	To feed for four lambs	65
Feb. 12	To dressing four lambs	1 50
Feb. 13	To six yards cleese cloth	30
Feb. 13	To one shipping crate	1 00
Feb. 13	To express charges on four carcasses shipped to Chicago	92
Feb. 13	To profit returned on four lambs	29 05
	Total	$37 40
	Cr.	
Feb. 13	By four lamb carcasses @ $9.00	36 00
Feb. 13	By four lamb pelts @ 35c	1 40
	Total	$37 40

Data relative to slaughtering the lambs are presented in the following table. The dressed weight of all the carcasses was 52 per cent of the live weight. At $9.00 each, the carcasses cost the buyers a little more than 41 cents per pound, which price indicates how highly winter lamb carcasses are prized by those who can afford to buy them.

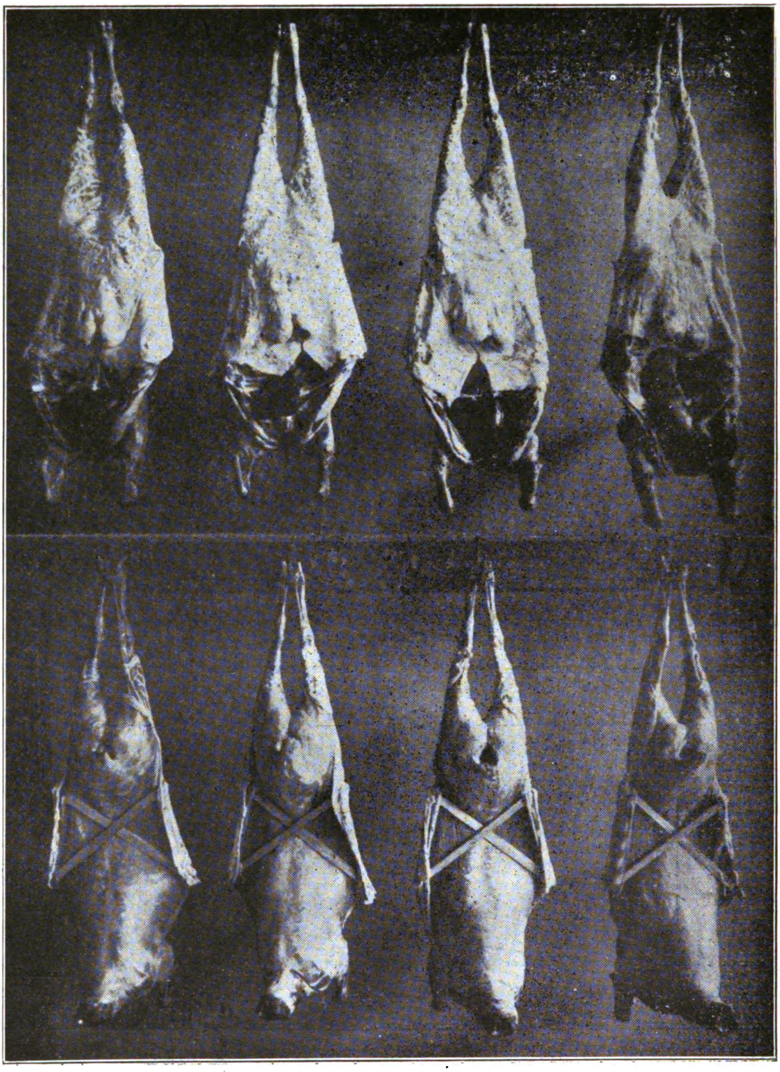


Fig. 7.—Carcasses of four winter lambs marketed February 13, 1906. Average weight 21.7 pounds. Price $9 per carcass.

TABLE VIII.—*Slaughter test for winter lambs, 1906.*

Lambs.	No. 553.	No. 554.	No. 555.	No. 556.
	Lbs.	Lbs.	Lbs.	Lbs.
Live weight	44 5	38.5	44.5	39.5
Dressed weight	22.5	19.4	24.0	21.0
Per cent of dressed weight	50.5	50.4	53 9	53.2
Pelt	4.2	3.5	4.8	3.7
Head	2.5	2.0	2.3	2.1
Intestines	10.7	9.8	9.5	8.8

In conclusion it may be said that the most disappointing feature of this trial was the failure to get more ewes to breed early enough to produce winter lambs. Where one can secure grade or pure-bred Dorset ewes and have them in good condition, there seems to be little question about their breeding in July, while with the other breeds, one cannot depend upon them, and it is only in exceptional cases that they will breed at that season of the year. The use of the Southdown ram gave compactness and excellent mutton quality to the lambs, and the cross is one which can be recommended. The price received for the lambs was extraordinary, but it emphasizes the fact that it pays to produce something of special value and cater to a high class trade which demands only the best. A general summary of the trial is given in the following table:—

TABLE IX.—*General summary of results for production of winter lambs for two years, 1905–1906.*

	1905	1906
Number of ewes which mated and were used in trials	6	2
Number of lambs produced and included in trials	7	4
Average age of ewes, years	5.1	5
Average weight of ewes at beginning of trial, pounds	181.5	180
Age of ram used for service, years	3	3
Weight of ram used for service, pounds	208	186
Average weight of lambs at birth, pounds	10.7	8.7
Average age of lambs when sold, days	75.2	59.5
Average weight of lambs at Madison when sold, pounds	60.4	41.7
Selling price per pound live weight, cents	18	22.4
Cost of feed consumed by ewes and lambs during trial	$15.75	$4.63
Cost of crating and marketing lambs	$9.40	$3.72
Total cost of producing and marketing lambs	$25.18	$8.35
Average net profit returned per head on lambs	$6.43	$7 26

DRIED BEET PULP FOR LAMBS.

GEORGE C. HUMPHREY AND FRANK KLEINHEINZ.

Beet pulp is a residue from the sugar beet after the sugar has been extracted. In its natural form it is a wet, pulpy mass of considerable bulk and weight. When fresh it possesses value for feeding sheep and cattle, but the difficulty of keeping it wholesome, and of transporting it prevents its being extensively used. A process of drying has been successfully adopted by several of the large factories in this and adjoining states. Two methods are employed. One is to thoroughly dry the pulp and offer it as dried beet pulp, and the other is to mix the green pulp with beet molasses (a refuse product of the sugar factory), dry it thoroughly, and place it upon the market as dried molasses beet pulp, which, by virtue of the molasses it contains, makes it somewhat more valuable than the former brand. After drying, both feeds are sacked and, if kept in dry quarters, will keep for an indefinite length of time.

Last winter a feeding experiment with the dried beet pulp was conducted with twenty lambs from the University flock, the pulp being supplied by the Rock County Sugar Company, Janesville, Wis. A chemical analysis of the dried beet pulp, and other feeds used in the trial, was made by the Chemistry Department and given in the following table:—

TABLE I.—*Composition of feeding stuffs fed, 1905–1906, in per cent.*

	Clover hay.	Oats.	Corn.	Dried beet pulp.
Moisture	6.14	12.25	15.61	4.41
Ether extract	2.30	3.91	3 13	73
Crude protein	14.69	10.13	8.72	8.31
Crude fiber	27.47	14.83	1.83	19.02
Nitrogen free extract	40.82	55.80	69.38	63.46
Ash	8.58	3.08	1.33	4.07
Dry matter	93.9	87.8	84.4	95.6
Digestible protein	7.6	7.8	6.6	5.8
Digestible carbohydrates and fat.	40.2	52.5	71.6	68.8
Nutritive ratio, 1:	5.3	6.7	10.8	11.9

The chemical analysis shows that dried beet pulp, compared with corn, against which it was fed in the experiment, contains a higher percentage of dry matter, crude fiber, and ash, and a much lower percentage of ether extract, or fat. The digestible protein, digestible carbohydrates and fat combined, and the nutritive ratio, do not vary greatly in these two feeds.

OUTLINE OF EXPERIMENT.

On January 13, 1906, twenty lambs were divided into two lots as nearly uniform as possible. They were all ewe lambs and the aim was to grow them for breeding purposes. The feeding, consequently, was moderate and the gain not as high as would be expected under forced conditions. The trial lasted thirteen weeks, the lambs being turned out daily for exercise when the weather permitted. For roughage both lots were fed as much clover hay as they would eat, and consumed practically the same amounts. Lot I was given a grain ration of whole oats and dried beet pulp, equal parts by weight, and Lot II, equal parts of whole oats and shelled corn. One pound of grain per head was fed daily to both lots throughout the trial, the lambs being fed both grain and roughage twice daily.

The following table gives the amounts of feed consumed and the gains made by the two lots:—

TABLE II.—*Results of supplementing whole oats with shelled corn versus dried beet pulp for growing lambs.*

	Lot I. Whole oats and dried beet pulp, equal parts.			Lot II. Whole oats and shelled corn, equal parts.		
	Grain.	Clover hay	Gain.	Grain.	Clover hay	Gain.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Initial weight	....	....	927	....	....	927
1st week	70	116.4	32	70	116.7	38
2nd week	70	119.8	13	70	123.8	13
3rd week	70	122.0	14	70	127.0	17
4th week	70	127.0	14	70	127.0	11
5th week	70	133.0	29	70	140.0	38
6th week	70	131.0	15	70	134.3	10
7th week	70	133.0	11	70	135.9	23
8th week	70	145.0	10	70	144.7	—1
9th week	70	155.7	25	70	157.7	18
10th week	70	157.0	15	70	152.4	18
11th week	70	144.4	14	70	143.6	11
12th week	70	141.0	11	70	135.6	9
13th week	70	137.7	17	70	123.9	17
Total	910	1,763.0	220	910	1,762.6	222

Summary.

	Lot I. Whole oats and dried beet pulp.	Lot II. Whole oats and shelled corn.
	Lbs.	Lbs.
Average weight per head at beginning of trial	92.7	92.7
Average weight per head at close of trial	114.7	114.9
Average gain per head during trial	22.0	22.2
Total grain consumed	910 0	910.0
Total roughage consumed	1,763.0	1,762.6
Roughage consumed per pound of gain	8.01	7.94
Grain consumed per pound of gain	4.14	4.10

The results favor the ration of whole oats and shelled corn by two pounds of gain in live weight and a saving of four-tenths of a pound of hay. For some unaccountable reason Lot II lost one pound during the eighth week, but made more than double the gain of Lot I for the previous week. With this exception the gains for both lots were uniform and practically equal.

The University flock was shorn ten days after the close of this trial and, as a matter of interest, the wool clip for the individual lambs of each lot is given in the following table:—

TABLE III. —*The effect of whole oats and dried beet pulp versus whole oats and shelled corn on wool production.*

Lamb.	LOT I. Whole oats and dried beet pulp.			Lamb.	LOT II. Whole oats and shelled corn.		
	Breed.	Body weight	Wool.		Breed.	Body weight	Wool.
		Lbs.	Lbs.			Lbs.	Lbs.
523.....	Shropshire	92	8.4	522....	Shropshire.........	102	9.1
524.....	Shropshire	129	9.6	510 ..	Shropshire.........	130	9.3
525.....	Shropshire	135	11.1	533 ..	Shropshire.........	117	6.7
505.....	Grade Shropshire .	103	9.5	501....	Shropshire.	112	8.4
490.....	Southdown	96	5.9	489....	Southdown	100	6.2
511.....	Southdown	112	6.6	512....	Southdown	101	6.0
502.....	Cheviot....	103	8.8	553....	Cheviot	118	7.6
537.....	Hampshire	134	7.4	492.. .	Oxford	134	7.9
516.....	Grade Southdown..	128	8.1	515....	Grade Southdown.	123	9.8
538.....	Grade Shorpshire. .	115	10.1	499....	Grade Shropshire..	112	9.9
Total	....	1,147	85.5	Total	....	1,149	80.9

The difference of four and six-tenths pounds of wool, in favor of Lot I as noted in the foregoing table, is not more than one would ordinarily expect from two lots of sheep of this character.

In conclusion it may be said that both feeds were satisfactory and practically equal for producing growth when used in connection with whole oats and clover hay. The health and the condition of the two lots were all that could be desired. Similar results were obtained *at the Michigan Experiment Station.** Dried beet pulp costs in the neighborhood of $15.00 per ton. Its economical use will depend on the price of corn. Last winter the shelled corn cost about $18.00 per ton, which made the ration of beet pulp and oats considerably more profitable.

* Bul. 220.

THE UNIVERSITY DAIRY HERD, 1905-1906.

GEORGE C. HUMPHREY AND F. W. WOLL.

Questions relating to the subject of feeding dairy cows have received considerable attention in the past by experiment stations in this country and abroad. At our own Station these questions are of special importance, due to the fact that dairying is one of the leading industries of the state, and practically all of our Station reports contain accounts of investigations bearing on these problems. During the past seven years our efforts in the study of this subject have centered around the problem of the most economical composition of rations for dairy cows under conditions similar to those existing in the north-central states.

As stated in our last annual report, the cows in our University dairy herd were, up to the year of 1903-1904, fed such rations as are generally given by progressive dairy farmers in this state. These are, on the whole, of rather wide nutritive ratios, being made up essentially of corn fodder, corn silage, hay, farm grains, and mill feeds, with a couple of pounds of oil meal per head. On such rations the thirty-eight cows which completed one or more years' records during the period 1898-1903 produced, on the average, about 307 pounds of butter fat per head annually. With the beginning of the year 1903-1904 the character of the rations fed to the cows was changed in so far as more highly nitrogenous grain feeds were fed after this time, and the nutritive ratios of the rations were thereby narrowed. As a result of this change, or coincident therewith, the average production of the twenty-one cows which completed a

full year's record during the following year was increased to 332 pounds of butter fat per head. Since the same cows were not in the herd during the entire period under consideration, it would not be safe to conclude that the new system of feeding was the sole cause of the increase in the production, but it was doubtless one of the factors contributing to this result.

The results obtained from the second year's feeding of nitrogenous rations are given in our last report and need not be considered in detail here, since this report is still available for distribution. Owing to several unfavorable conditions, which are discussed at some length in the report, and to the fact that a number of young cows were added to the herd at the beginning of the year, there was a marked decrease, both in the average production of the cows during this year compared with the preceding one, and in the profits which the cows returned over and above the cost of the feed. The average figures for the year 1904–1905 for the thirty--four cows in the herd were as follows: Milk 6,439.5 pounds; butter fat 280.80 pounds; average net profit per head $35.20.

During the year just closed, which was the third year of feeding rather narrow nutritive ratios to our dairy herd, the system of feeding was similar to that of the two previous years, the concentrated feed being, as a general rule, made up of mixtures of the three feeds, wheat bran, distillers' grains, and cotton seed meal, fed in the proportion of 2:2:1, by weight. Considerable pains was taken throughout the year to adjust the amounts of grain fed to the individual cows according to their capacity at any time to give economic returns for the feed in the production of milk and butter fat, and no cows were fed more concentrates than their production entitled them to at a given time simply for the purpose of making records. The amount of grain fed from day to day to mature cows in a normal condition of flesh was, as in the past, one pound for each pound of butter fat produced per week. Only in a few cases where a cow was thin in flesh, or in the case of heifers and young cows, a somewhat larger grain allowance was fed.

As in earlier years, the roughage fed the cows consisted of corn silage, soiling crops, mixed hay, and some alfalfa hay.

The last feed was fed for a time to a few of the highest producers in the herd. It was aimed to feed all cows as much roughage as they would eat up clean. The results of the last year's feeding will be seen from the data presented in the following pages, where a detailed discussion of the same will also be found. The same general plan of presentation as was adopted in earlier reports has been adhered to in the following account of this year's results.

COWS IN THE DAIRY HERD, 1905–1906.

The following table gives the names of the thirty-two cows in our University dairy herd during the past year, with data relating to the breed, age, and date of calving of each one. The list includes 7 Jerseys, 8 Guernseys (2 grades), 8 Holsteins (1 grade), 3 Shorthorns (1 grade), 4 Red Polls (1 grade), and 2 Brown Swiss. Of this number thirty cows completed a year's record on May 16, 1906, the close of the period considered in this report; complete data for the winter period from November 15, 1905 to May 16, 1906, are at hand for the same number of cows.

Two cows, Muriel and Josephine, were kept at the Hill Farm during the year, on account of their having aborted during the winter of 1904–1905. Their milk was weighed and sampled during this time, but as it could not be arranged at this farm to weigh the feed eaten, the data for these cows have not been included in the herd records given in the following pages.

Only five cows were added to the herd during the year, viz., Mary, Gyp, Just in Time, Queen, and Marie. The last two cows were not placed in the herd until February, 1906, and their records are not, therefore, considered in this report. A brief description of the three other new cows in the herd will be of interest at this point.

Gypsy's Model Mary (Mary).—Guernsey, dropped March 22, 1903; bred at the University farm. Her dam is Model Mary, one of the original lot of Guernseys in the University dairy herd. Mary is a half-sister to

TABLE I.—*List of cows in University dairy herd, 1905–1906.*

NAMES OF COWS.	Breed.	Date of birth.	DATES OF CALVING. 1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.
Brown Bessie's *Laura* Lee, 140963	Jersey	Jan. 20,'95.			Spring.	Aug. 6.	July 26.	Oct. 3.		Apr. 26.
Brownie	Jersey	1897.			Aug. 6.	Nov. 5.	Dec. 1.	Dec. 24.		May 2.
Double Time, 157531	Jersey	Mar. 25,'99.					Mar. 16.	Sept. 17.	Sept. 14.	
Macella 3d, 149721	Jersey	Nov. 17,'99.					Aug.	Sept. 11.	Sept. 24.	
Perchance, 153118	Jersey	Nov. 27,'99.						Sept. 1.	Sept. 26.	
Diploma's *Broadway*, 132562	Jersey	May 5,'98.						Feb. 6.	Feb 25.	Mar. 10*
Just in Time, 177907	Jersey	Mar. 15,'03.							June 18.	
Floradora of Tawawa, 14485	Guernsey	June 1,'01.					May		Apr. 30.	May 3.
Fair *Cozie*, 15690	Guernsey	Jan. 25,'00.					Dec. 16.	Dec. 10.		Mar. 17.
Sammy's Calla *Lily* 2d, 12206	Guernsey	Apr. 8,'98.							Feb. 21.	
Lady *Jeweletta*, 15688	Guernsey	Nov. 9,'98.					Dec. 18.	Nov. 9.	Dec. 7.	
Gypsy's Jennie (*Gyp.*), 16635	Guernsey	Feb. 27,'03.							Apr. 28.	May 6.
Gypsy's Model *Mary*, 16636	Guernsey	Mar. 22,'03.							May 27.	
Dorine	Grade Guernsey.	1900.				Jan. 13.	Mar. 12.	Mar. 31.	May 29.	
Alma Marie 3d, 41417	Holstein	Mar. 23,'96.	Aug. 13.	Sept. 12.	Aug. 24.	Dec. 14.		Jan. 20.	Mar. 28.	Mar. 12.
McGeoch	Holstein	1899.			Jan. 19.	Feb. 11.	Feb. 7.	July 25.		Jan. 10.
Alma Marie Josephine (*Joe*), 54846	Holstein	Aug. 13,'99.			Aug. 6.	Nov. 5.	Dec. 1.		Apr. 4.	Apr. 27.
Maggie Morris 2d, 49440	Holstein	Mar. 25,'98.					Mar. 19.	Aug. 31.	Oct. 8.	
Netherland *Artis* Mechthilde, 59609	Holstein	Sept. 13,'01.					Dec. 5.		Apr. 2.	Apr. 8.
Johanna Clothilde 4th, 60986	Holstein	Nov. 8,'01.					Dec. 25.	Dec. 17.	Dec. 7.	
Alma *Maxie* Netherland, 66417	Holstein	Dec. 14,'02.						Dec. 25.	Dec. 9.	
2d Miss *Campbell* by Doubleday, v. 29, p. 290	Shorthorn	Nov. 10,'93.	Dec. 6.	Dec. 13.		Jan. 13.	May 5.	July 24.		Mar. 17.
Julia 13th of Oak Grove, vol. 47, p. 341	Shorthorn	Nov. 11,'96.					Oct. 16.	Sept. 17.		
Maud	Grade Shorthorn	July 27,'93.	June 14.	Sept. 6.	Dec. 18.	Nov. 30.		Feb. 1.	Aug. 25.	
Topsy, 14329	Red Polled	Aug. 7,'98.					Summer		Apr. 14.	May 1.
Celia, 18039	Red Polled	June 29,'01.					Nov. 24		May 28.	
Lina, 10427	Red Polled	Mar. 1,'95.					Spring.	Apr. 26.	Mar. 25.	Apr. 23.
Lady	Grade Red Polled	1898.			Aug. 7.	Oct. 13.	Dec. 27.		Mar. 10.	Mar. 21.
Atilla, 1123	Brown Swiss	July 27,'94.							Feb. 19	Mar. 27.
Clara Barton, 1567	Brown Swiss	Sept. 19,'97.						Jan. 27.	Feb. 14.	Apr. 19.

* Aborted.

Model Times, which was disposed of last year on account of her low production and other undesirable characteristics. Mary has been discarded this year for similar reasons. She has been given only one year's trial, but her small body, high from the ground, and the poor development of her udder and milk veins, are unpromising features, which, together with this year's low production, do not warrant us in giving her a further trial.

Gypsy's Jennie (Gyp).—Guernsey, dropped Feb. 27, 1903. She was also bred at the University farm. Her dam is Model Times, and her sire, Gypsy's John, which was also the sire of the preceding heifer, thus making the two heifers closely related. Gyp has proved herself a more persistent milker than the other members of this family, but she has the characteristic fault of being too small in size, and lacking in vigor and nervous temperament. Owing to the fact that her production as a two-year-old was very creditable, she will be retained in our herd another year, and given a chance to develop better, if possible, in form and in dairy qualities.

Just in time.—Jersey, dropped March 15, 1903; bred by F. C. Warren, Fox Lake, Wis. Her dam is Double Time, one of the best Jersey cows in our herd, and under favorable conditions she promises to equal her dam. Prior to producing her first calf she was very fleshy, but after being milked a short time, her form was reduced to that of a typical dairy animal, which gives evidence of her strong milking tendencies. She would very likely have made an excellent record for a two-year-old but for the fact that she got "off feed" six months after freshening, and later in the year had an attack of actinomycosis. She was successfully treated for this disease, and will be retained in the herd for further trial.

The records given in our last annual report for thirteen cows closed with the summer period of 1904, and all but two of these were in our herd during the year considered in this report, ending May 16, 1906. As it will facilitate our discussion to a considerable extent to have all records for the cows in the herd cover the same period, it has been decided to have the records close for all cows on the date given. For the sake of strict comparison with the records previously published, the production of these cows for the period corresponding to those of the earlier records is given in foot notes in the table of Herd Records for 1906.

CONDITION AND MANAGEMENT OF THE HERD.

There was no serious sickness among the cows in the herd during the past year, but a few cases of diseases that are common in dairy herds occurred, the most serious being the case of abortion of Broadway on March 10, 1906, which necessitated her being placed in quarantine for the rest of the year. Maggie and Jeweletta suffered from attacks of garget during the year, which reduced their production and doubtless shortened their lactation periods. Just-in-Time was operated on for actinomycosis on April 6, as already mentioned. Atilla's and Broadway's teats were accidently injured, in the case of the former cow with the result that one quarter of her udder was lost. The following cows were "off feed" for short periods, viz, Johanna, Perchance, Floradora, Topsy, Lady, and Celia. Julia and Lily failed to breed at the proper time, which unduly lengthened their lactation periods and will doubtless considerably reduce the amount and the economy of their production.

The care and the management of the herd and the testing of the weekly composite samples of milk from the individual cows were also this year in the hands of Mr. J. C. McComb, Dairy Herdsman, to whom acknowledgment is due for faithful and efficient work in the discharge of his duties. We are also indebted to Mr. R. T. Harris, Supervisor of Dairy Tests, for valuable assistance in the compilation of the herd records given in this report, and to Mr. Geo. A. Olson, Assistant Chemist, for analytical work in connection with the samples of feeding stuffs fed at the dairy barn during the winter.

DAIRY HERD RECORDS, 1905–1906.

The amounts of the various kinds of feed eaten by the cows during the year, with the production of milk and butter fat, the value of the products, the cost of the feed eaten, and the net profit returned by each cow over and above the cost of the feed are shown in following tables. The live weights and the number of days in milk during the year are also given for each cow.

TABLE II.—*Feed consumption per cow, in pounds, University dairy herd, 1905-1906.*

No.	NAME.	Alfalfa	Hay.	Silage.	Soiling crops.	Roots.	Bran.	Oats.	Corn.	Oil meal.	Beet pulp.	Gluten meal.	Cotton seed meal.	Distillr's grains.	Cost of feed.
1	Lady		1,519	11,778	910		862.4	455.8	28.0	300.6	57.5	145.2	153.0	435.0	$48.74
2	Johanna	581	1,290	9,778	910		895.3	562.9	57.5	320.0	57.5	307.4	23.1	433.8	49.83
3	Marcella	360	836	7,120	90	400	921.7	541.9	104.5	450.0	93.5	223.5	257.2	516.2	48.82
4	Maggie	205	1,207	8,380	257	430	879.1	614.4	116.8	343.3	57.5	211.7	259.9	551.8	50.33
5	Double Time	280	920	7,965	210		982.7	434.7	102.9	259.0	63.5	137.9	313.2	588.6	46.96
6	Dorine		1,288	10,330	805		592.2	215.6	25.2	61.0	43.5	25.2	131.4	523.4	38.34
7	Floradora	316	960	9,768	740		658.0	501.7	86.6	440.6	6.0	125.6	106.6	291.8	43.57
8	Topsy		1,506	9,137	1,036		517.5	107.6	41.8	177.9	43.5		100.4	486.8	37.11
9	Jewel'etta	483	1,066	7,472	757		814.2	[illegible]	10.1	346.4	43.5	219.8	57.5	371.4	44.03
10	Maxie	504	1,265	9,980	910		873.7	347.9	48.0	168.1	57.5	129.6	141.1	491.6	46.06
11	Broadway		1,288	8,051	722		745.0	157.2	42.0	152.4	39.5	39.2	233.1	447.0	38.72
12	Joe		1,517	11,008	910		645.1	311.5	53.6	120.6	57.5	22.2	135.0	458.2	41.67
13	Atilla		1,483	9,946	910		584.4	76.2		77.0	24.0	22.3	133.2	298.3	34.91
14	Alma		1,517	10,730	910		680.8	83.8	[illegible]	130.0	57.5	53.2	134.0	321.2	39.65
15	Artis		1,503	10,388	910		591.6	215.2	70.6	98.4	49.5	80.4	82.4	506.0	39.93
16	Just in Time		1,253	7,649	687		488.9	356.1	231.6	124.2	29.5	28.8	69.6	148.8	32.32
17	McGeoch		1,330	7,582	787		566.0	381.6		175.5	57.5	127.6	72.2	314.0	35.55
18	Lily	333	804	7,996	827	560	708.5	590.9	96.3	411.9	22.0	167.1	83.8	264.1	42.53
19	Brownie		1,288	9,342	722		596.0	16.8	4.0	23.0	43.5	40.0	142.8	488.4	34.81
20	Perchance	112	1,104	8,490	447		810.0	109.2	36.4	210.0	11.0	36.4	310.7	571.8	40.97
21	Cozie		1,288	8,335	722		606.4	114.6		45.0	43.5	72.4	186.4	263.2	33.09
22	Gyp		1,274	7,732	675		551.8	119.6	56.8	29.6	43.5		95.4	328.8	30.85
23	Clara		1,517	10,718	892		557.4	125.6	59.2	67.8	42.0		10.0	332.0	36.20
24	Mary		1,278	8,541	687		418.6	60.0	30.0	15.0	19.5		110.8	401.6	30.84
25	Julia		1,499	11,280	910		333.4		2.0		49.5	23.2	86.0	478.4	34.83
26	Lina		923	7,360	666		703.2	14.0	111.0	37.0	43.5	29.6	213.6	43.4	32.73
27	Laura		1,286	9,119	687		351.4	88.2	23.2	44.6	28.0	11.2	62.4	132.0	28.20
28	Celia		1,499	10,219	897		395.2	46.4	23.2	11.6	43.5		44.8	433.6	33.27
29	Maud		1,513	10,492	892		314.6	46.4	27.2	11.6	43.5		74.4	370.8	32.80
30	Campbell		1,391	7,401	732		170.6	109.0		45.0	28.0	68.0	12.8	93.6	24.73
	Average (30 cows)	106	1,280	9,136	745	46	623.2	247.6	56.0	156.2	43.3	78.3	130.6	392.6	$38.41

TABLE III.—*Production per cow, University dairy herd, 1905—1906.*

No.	NAMES OF COWS	Live weight.	DAYS IN MILK. At beginning of year.	DAYS IN MILK. During year.	Annual milk.	Per cent. fat.	Annual fat	Butter.	Value of products.	Cost of feed.	Net profit.
		Lbs.			Lbs.		Lbs.	Lbs.			
1	Lady	1,183	68	315	11,287.5	3.98	449.73	525	$118 55	$48 74	$69 81
2	Johanna	1,165	151	321	11,681.5	3.68	430.29	502	114 42	49 83	64 59
3	Macella[1]	983	248	318	7,810.7	5.65	441.65	515	112 37	48 82	63 55
4	Maggie	1,318	259	318	12,134.0	3.45	418.41	488	112 16	50 33	61 83
5	Double Time	1,015	242	328	9,189.4	4.53	416.38	486	108 23	46 96	61 27
6	Dorine	1,060	Dry.	352	7,309.4	5.18	378.95	442	97 17	38 33	58 84
7	Floradora[2]	1,075	17	337	7,649.4	5.08	388.33	453	99 78	43 57	56 21
8	Topsy[3]	1,195	33	328	8,430.9	4.03	339.36	396	89 32	37 11	52 21
9	Jeweletta[4]	997	189	336	8,083.8	4.56	368.68	430	95 70	44 03	51 67
10	Maxie	1,003	143	320	11,682.6	3.00	350.09	408	95 62	46 06	49 56
11	Broadway	936	81	364	5,735.2	6.02	345.33	403	87 48	38 72	48 76
12	Joe	1,174	43	302	9,886.3	3.40	336.08	392	90 26	41 67	48 59
13	Atilla[5]	1,097	87	284	7,454.6	4.01	298.90	349	78 75	34 91	43 84
14	Alma	1,099	50	335	10,394.7	2.91	302.36	353	83 07	39 65	43 42
15	Artis[6]	1,002	45	331	8,142.1	3.83	312.00	364	82 57	39 93	42 64
16	Just in Time	811	....	333	5,507.3	5.07	279.30	326	71 81	32 32	39 49
17	McGeoch	1,414	296	260	7,313.8	3.76	275.16	321	72 98	35 55	37 43
18	Lily	1,018	85	364	8,095.2	3.63	294.26	343	78 31	42 53	35 78
19	Brownie[7]	1,067	144	327	5,012.1	5.43	271.95	317	69 41	34 81	34 60
20	Perchance	971	258	323	6,637.8	4.37	289.99	338	75 57	40 97	34 60
21	Cozie[8]	981	158	336	4,497.6	5.67	255.02	298	65 00	33 09	31 91
22	Gyp	796	19	324	5,020.0	4.73	237.42	277	61 42	30 85	30 57
23	Clara[9]	1,262	92	299	6,451.0	3.90	251.48	293	66 34	36 20	30 14
24	Mary	869	....	355	4,572.1	4.88	223.24	260	57 49	30 84	26 65
25	Julia	1,358	242	364	6,509.7	3.52	228.91	267	61 21	34 83	26 38
26	Lina[10]	1,001	53	305	5,925.6	3.59	212.74	248	56 71	32 73	23 98
27	Laura	975	226	279	3,841.1	4.81	184.64	215	47 61	28 20	19 41
28	Celia[11]	1,222	Dry.	354	5,205.1	3.81	198.44	232	52 65	33 27	19 38
29	Maud[12]	1,192	265	282	4,745.9	3.99	189.42	221	49 90	32 80	17 10
30	Campbell[13]	1,176	297	144	3,647.5	3.78	137.76	161	36 58	24 73	11 85
	Average (30 cows)	1,081	126	316	7,328.6	4.11	303.54	354	79 61	38 41	41 20

[1] 1904-5 (year ending Nov. 15, '05), 5,903.8 lbs. milk, 339.86 lbs. fat. [2] 1904-5, 6,443 8 lbs. milk, 324.22 lbs. fat. [3] 1904-5, 6,921.3 lbs. milk, 275.32 lbs. fat. [4] 1904-5, 8,154.0 lbs. milk, 373.26 lbs. fat. [5] 1904-5, 8,201.1 lbs. milk, 324 36 lbs. fat. [6] 1904-5, 7,239 0 lbs. milk, 275.96 lbs. fat. [7] 1904-5, 6,850.0 lbs. milk, 366.25 lbs. fat. [8] 1904-5, 5 263.3, lbs. milk, 287.01 lbs. fat. [9] 1904-5, 6 787.0 lbs. milk, 280 81 lbs. fat. [10] 1904-5, 5,652.9 lbs. milk, 196.59 lbs. fat. [11] 1904-5, 3,606.9 lbs. milk, 136.71 lbs. fat. [12] 1904-5, 7,598.9 lbs. milk, 294.18 lbs. fat. [13] 1904-5, 5,691.5 lbs. milk, 211.33 lbs. fat.

The same prices of feeds and products have been used in the compilations of these results as heretofore, with the exception of wheat bran, which this year has been figured at 75 cents a hundred pounds.

SCHEDULE OF PRICES OF FEEDS AND PRODUCTS, 1905-1906.

Alfalfa hay, per hundred pounds	$0 60
Hay, per hundred pounds	40
Corn silage, per hundred pounds	12½
Soiling crops, per hundred pounds	07½
Roots, per hundred pounds	15
Pasture for season	4 50
Wheat bran, per hundred pounds	75
Oats, per hundred pounds	80
Corn, per hundred pounds	70
Oil meal, per hundred pounds	1 20
Gluten meal, per hundred pounds	1 10
Distillers' grains, per hundred pounds	1 10
Cotton seed meal, per hundred pounds	1 30
Beet pulp or molasses pulp, per hundred pounds	80
Butter, per pound	20
Skim milk, per hundred pounds	15

In crediting the cows with the value of products, the butter has been calculated from the production of butter fat by the addition of 1-6, and figured at 20 cents per pound; it has furthermore been assumed that 80 per cent. of the milk was returned as skim milk, and the value of the latter was placed at 15 cents per hundred pounds. With these remarks, the tables are self-explanatory. The data for the cows have been given in the tables in the order of decreasing net profits during the past year.

DISCUSSION OF HERD RECORDS, 1905–1906.

It will be noted from the foregoing tables that the Red Polled cow Lady this year again leads in economic dairy production, being credited with a net profit for the year of $69.81, and a production of 11,287.5 pounds of milk and 449.73 pounds of butter fat, equivalent to 525 pounds of butter. The value of her production, figured at 20 cents per pound for butter, and 15 cents per hundred pounds for skim milk, amounted to

$118.55, and the cost of the feed which she ate during the year amounted to $48.74. This cow has made a remarkable record during her life in our herd, as will appear from earlier accounts of these investigations. During the first year with us she produced, as a four-year-old, 384 pounds of butter fat, and her production for the succeeding years (1902–1906) has been as follows: 449, 493, 416, and 450 pounds, an average of 438 pounds of butter fat for five years, equivalent to 511 pounds of commercial butter. While she has generally ranked first in production and in net profit among the cows in our herd, she has not been an expensive feeder. During the past year she ranked fourth in the cost of feed eaten. A description of Lady will be found in our Bulletin No. 102, page 27, and reference to her later records, in our Twenty-First Annual Report, page 96, and our Twenty-Second Annual Report, page 89.

The Holstein cow Johanna ranked second in net profit yielded during the past year with a production of 11,681.5 pounds of milk, 430.29 pounds of butter fat, and a net profit of $64.59 to her credit. This is her second year in our herd; her record published in our last annual report showed a production of 297.33 pounds of butter fat as a four-year-old, with a net profit of $38.19.

The Jersey cow Macella takes third rank in the preceding table, being credited with 7,810.7 pounds of milk, 441.65 pounds of butter fat, and a net profit of $63.55 for the year. During the preceding year, which was her first one in our herd, Macella produced 276 pounds of butter-fat and yielded a net profit of only $33.73. The records of both this and the preceding cow furnish further evidence of the correctness of the statement made in our last year's report (page 92) that a cow is not likely to do justice to herself or her owners during her first year in a herd.

Considering next, as a contrast to the records of the preceding cows, some of the low records made, we note that the two Shorthorn cows Campbell and Maud, and the Red Polled cow Celia, gave the lowest net profits of any cows in the herd, with only $11.85, $17.10, and $19.38, in the order given, as the net returns for the year; i. e., these three cows together yielded a

net profit of only 70 per cent of that of the best cow in the herd last year; moreover, the value of the feed eaten by these three cows was nearly twice that of any single cow in the herd. The low records made by the two Shorthorn cows are accounted for by the advanced age of these cows, they being now thirteen years old. Both of these cows have, however, made good earlier records in our herd; Campbell yielded an average net profit during the five preceding years of $40.51, and Maud, one of $50.20 during the six preceding years. The Red Polled cow Celia, on the other hand, was one of the poorest cows in our herd during the year 1904–1905, which was her first year in the herd. The records which she has made these two years have shown conclusively that she is incapable of profitable dairy production. She was, therefore, discarded from the herd at the close of the period considered in this report.

CHANGES IN LIVE WEIGHT.

The changes in the weights of the cows during the year, or the winter periods for which records are published in this article, were ascertained by comparing the average figures for the first three and the last three regular weekly weighings for the two periods considered. As some cows dropped calves during this time, or were heavy in calf either at the beginning or the end of these periods, it is difficult, and often impossible, to determine to what extent the changes observed in the weights of the cows were due to the effect of the system of feeding practiced or were influenced by parturition. The average weights of the cows for both the beginning and the end of either the year or the winter period, with differences, are given in the following table.

It will be seen that the body weights of the cows were influenced, in a large majority of cases, by calving. The yearly data for only four cows are of value in determining the effect of the feed on the weight of the cows. Of these cows only one lost weight during the year, viz., Just in Time, while three cows gained an average of 180 pounds, viz., Lily, Julia, and Celia. The figures for the winter periods will be referred to later in this article.

TABLE IV.—*Average live weight, University dairy herd*, 1905–1906

Name of cow.	For the year.			Winter period.		
	Beginning.	End.	Difference.	Beginning.	End.	Difference.
Laura	903	927	+ 24*	985	927	− 58*
Brownie	968	1,067	+ 99*	1,086	1,067	− 19*
Double Time	1,001	997	− 4*	1,037	997	− 40
Macella	923	988	+ 65*	976	988	+ 12
Broadway	841	845	+ 4*	965	945	− 20*
Perchance	900	982	+ 82*	962	982	+ 20*
Just in Time	831	806	− 25	822	806	− 16
Floradora	958	1,011	+ 53*	1,119	1,011	− 108*
Cozie	896	930	+ 34*	1,020	930	− 90*
Jeweletta	963	963	....	1,024	963	− 61
Lily	871	1,070	+ 199	1,051	1,070	+ 19
Gyp	685	780	+ 95*	810	780	− 30*
Mary	758	974	+ 216*	851	974	+ 123*
Dorine	979	1,111	+ 132*	1,074	1,111	+ 37*
Alma	969	1,058	+ 89*	1,114	1,058	− 56*
McGeoch	1,336	1,281	− 55*	1,500	1,281	− 219*
Joe	1,058	1,127	+ 69*	1,179	1,127	− 52*
Maggie	1,246	1,220	− 26*	1,302	1,220	− 82
Artis	857	993	+ 136*	1,034	993	− 41*
Johanna	1,009	1,167	+ 158*	1,299	1,167	− 132*
Maxie	897	999	+ 102*	1,004	999	− 5
Campbell	1,123	1,030	− 93*	1,217	1,030	− 187*
Julia	1,196	1,394	+ 198	1,359	1,394	+ 35
Maud	1,085	1,308	+ 223*	1,205	1,308	+ 103*
Topsy	1,104	1,167	+ 63*	1,160	1,167	+ 7*
Celia	1,117	1,260	+ 143	1,240	1,260	+ 20
Lina	860	926	+ 66*	1,020	926	− 94*
Lady	1,102	1,155	+ 53*	1,222	1,155	− 67*
Atilla	999	898	− 101*	1,147	898	− 249*
Clara	1,123	1,247	+ 124*	1,260	1,247	− 13*

* Weight influenced by parturition during or shortly before or after period considered.

AVERAGE DATA FOR THE HERD, 1905–1906.

The thirty cows, for which complete data are at hand for the year just finished, produced on the average 7,328.6 pounds of milk and 303.54 pounds of butter fat. The average value of their product, was $79.61, and the average cost of the feed eaten, $38.41, leaving a net profit of $41.20 per cow for the year. The average cost of feed per hundred pounds of milk for the whole herd was 52.4 cents, and the cost of the feed per pound of butter fat, 12.7 cents. For the sake of comparison, similar data for the two previous years are given in the following table.

The average figures given in the table show that there is, on the whole, a marked improvement in the production of milk

and butter fat by the herd during the year just completed, as compared with the preceding year, although the high average results reached by the smaller number of cows in the herd during the year 1903–1904 were not attained. The rather unfavorable showing made by the herd during the year 1904–1905 was discussed at some length in our last annual report.*

TABLE V.—*Average data for the University dairy herd, 1903-1906.*

	1903-1904.	1904-1905.	1905-1906.
Number of cows in herd	21	24	30
Average days in milk	329	310	310
Average live weight, pounds	1,073	1,046	1,061
Average age, years	6.7	6.7	7.5
Average production of milk, pounds	7,913.0	6,439.5	7,328.6
Average production of fat, pounds	332 33	280.80	303.54
Equivalent to pounds of butter	388	327	354
Per cent. fat in milk	4.20	4 36	4.14
Average value of products, dollars	87.10	73.19	79.61
Average cost of feed, dollars	38.24	37.99	38.41
Average net profit per head, dollars	48.86	35.20	41.20
Cost of feed per 100 pounds milk, cents	48 3	59.0	52.4
Cost of feed per pound butter fat, cents	11.5	13.5	12.7

The average cost of feed eaten during the past year was slightly higher than that of the two preceding years, but it will be noted that, on account of the greater average production of the herd, the average cost per hundred pounds of milk and per pound of butter fat was reduced to a considerable extent, as compared with that of 1904–1905.

The herd was not composed of the same cows during these years, and the average data obtained for the herd for different years are not, therefore, strictly comparable. The average records for all cows that have been in the herd for an entire period of two to eight years have been calculated, and are given in the following table, which shows the data obtained for nine cows for all four periods, 1898–1906, for eleven cows for the last three years, and for twenty-four cows for the last two years.

*22d Ann. Rpt., p. 91–93.

TABLE VI.—*Comparison of herd records, 1898–1906.*

	Number of cows.	Average production of butter fat.	Value of products.	Cost of feed.	Net profit.
Series of four periods, 1898–1906.		Lbs.			
1898–1903	9	336.89	$88 52	$41 07	$47 45
1903–4	9	349.36	91 96	39 40	52 56
1904–5	9	311.74	81 85	40 79	41 06
1905–6	9	280.67	73 25	36 05	37 90
Series of three years, 1903–1906.					
1903–4	11	355.82	93 71	39 98	53 73
1904–5	11	314.78	82 67	41 44	41 23
1905–6	11	305.53	80 54	38 34	42 20
Series of two years, 1904–1906.					
1904–5	24	298.32	77 93	39 56	38 37
1905–6	24	309.67	81 18	38 70	42 48

The decrease in the production and in the net profit yielded by the cows due to advancing age, is plainly shown in the four- and three-period compilations (average age of cows in both series, 1906, 9 years). The comparison of the records of the twenty-four cows for the past two years, on the other hand, shows a gain in the average production and in the value of the production with the last year, with a somewhat lower average feed cost, making the average net profit returned last year by these cows about $4.00 higher than the preceding year (average age of this group of cows last year, slightly over 8 years). Fourteen cows produced more butter fat, and sixteen yielded a larger net profit during 1905–1906 than in the preceding year. We note, therefore, that on the average, there was a decided improvement in the production and in the net profit yielded by a majority of the cows in our herd during the year just completed, as compared with the year 1904–1905.

AVERAGE PRODUCTION OF COWS IN THE DAIRY HERD, 1898–1906.

It is of interest to ascertain the average yearly records of the various cows during their entire life in our dairy herd, and the production of the cows for these years has, therefore, been calculated and is given in the following table, the cows being arranged in this table in the order of decreasing net pro-

fits for the number of years they have been in the herd. The rank of the cows during the years 1898–1905, 1904–1905, and 1905–1906, is shown by the figures in the last three columns of the table.

TABLE VII.—*Average annual production per cow, University dairy herd, 1898–1906.*

NAME OF COW.	Number of years.	Years.	Milk.	Per cent fat.	Fat.	Value of products.	Cost of feed.	Profit.	RANK. 1898–1905.	1904–1905.	1905–1906.
			Lbs.		Lbs.						
1. Lady	5	1901–1906	10,799.1	4.06	438.42	$115.24	$51.40	$63.84	1	2	1
2. Maggie..........	3	1903–1906	11,125.9	3.41	379.64	101.90	46.30	55.60	2	11	4
3. Double Time ...	3	1903–1906	7,941 1	4.71	374.17	93.84	44.07	52.77	6	7	5
4. Johanna	2	1904–1906	9,737.4	3.74	363.81	96.59	45.20	51 39	22	18	2
5. Maxie...........	1	1905–1906	11,682.6	3.00	350.09	95.62	46.06	49.56	....		10
6. Dorine	4	1902–1906	6,019.6	5.35	321.96	82 35	33.63	48.72	11	6	6
7. Macella	2	1903–1906	6,199.1	5.79	358.80	91.14	42.50	48.64	25	22	3
8. Topsy	2	1903–1906	7,982.5	4.14	330.58	86.68	39 89	46.81	14	8	8
9. Jeweletta	2	1903–1906	7,146.7	4.58	327.26	84.88	39.06	45.82	17	12	9
10. Alma	7	1899–1906	10,843.7	3,10	336.24	91.45	45.73	45.74	10	19	14
11. Maud	7	1898–1906	8,108 0	3,98	323.01	85.07	39.60	45.47	5	9	29
12. McGeoch	5	1901–1906	8,899.7	3.63	326.32	86.84	41.80	45.04	7	23	17
13. Broadway...	2	1904–1906	5,323.2	6,00	319.36	80.89	36.78	44.11	21	16	11
14. Floradora	2	1903–1906	6,213.0	5.26	326.61	83.66	39.92	43.74	26	24	7
15. Joe	4	1902–1906	9,225 3	3.51	323.63	86.61	42.89	43.72	13	27	12
16. Brownie.........	4	1901–1906	5,602.5	5.54	310.22	79.08	35.64	43.44	9	1	19
17. Atilla	2	1903–1906	7,235.1	4.07	294.45	77.47	35.73	41.74	20	15	13
18. Just in Time....	1	1905–1906	5,507.3	5.07	279.30	71.81	32.32	39.49	....	..	16
19. Artis	2	1903–1906	7,843.3	3.92	307.66	81.22	42.27	38.95	23	21	15
20. Julia	2	1904–1906	8,054.6	3.69	297.46	79.07	40.15	38.92	4	4	25
21. Laura...........	4	1902–1906	5,639.2	5.10	287.49	73.81	36.70	37.11	12	17	27
22. Cozie...........	2	1903–1906	4,813.2	5.77	277.52	70.58	34.67	35.91	18	13	21
23. Lily	1	1905–1906	8,095 2	3.63	294.26	78.31	42.53	35.78		....	18
24. Campbell	6	1899–1906	7,024.3	3.70	260 26	69.13	33.40	35.73	16	25	30
25. Clara	2	1903–1906	6,617.4	3.96	261.88	69.05	33.51	35.54	15	10	23
26. Perchance	1	1905–1906	6,637.8	4.37	289.99	75.57	40.97	34.60	....	....	20
27. Gyp	1	1905–1906	5,020.0	4.73	237.42	61.42	30.85	30.57	....	...	22
28. Mary	1	1905–1906	4,572.1	4.88	223 24	57.49	30.84	26.65	....	....	24
29. Lina	2	1903–1906	5,958.4	3.81	226.75	60.06	35.43	24.63	29	28	26
30. Celia	2	1903–1906	4,683.1	4.10	191.99	50.43	35.22	15.21	32	32	28
Average (30 cows).	....	....	7,351.7	4.19	307.96	$80.67	$39.17	$41.50	....	....	....

The average data given in the preceding table show that the Red Polled cow Lady again leads in the yearly records made by the cows during their life in our dairy herd, with an average annual production of 438.42 pounds of butter fat for a period of five years, and an average net profit for this period of $63.84. The cows mentioned below follow in the order given: Maggie (Holstein), Double Time (Jersey), Johanna and Maxie (Holsteins), Dorine (Guernsey), etc. All of these cows, except the Holstein heifer Maxie, have records for two or more

years. At the end of the list, on the other hand, we find two Red Polls, Celia and Lina, with an average production of 191.99 and 226.75 pounds of butter fat, respectively, and net profits of $15.21 and $24.63. Further discussions of the records of these and other cows, for which average data are given in the table, will lead to a consideration of the relative merits of different breeds of cows, and will therefore be postponed until the average data for the various breeds in our dairy herd have been considered.

COMPARISON OF BREEDS, 1905–1906.

The records made by cows of the various breeds during the past year have been summarized, and the average data for each breed represented in our dairy herd are given in the following table. The table gives the main facts relating to the representatives of the breeds in the herd, viz., number of cows, average age and weight of each, days in milk, production of milk and butter fat, value of production, cost of feed, and average net profit both for the past year and for the entire period during which records are at hand for the present representatives of the breeds in our herd. In the latter case, as in previous years, the data given are the arithmetical means of the average records made by each cow during her life in the herd; i. e., each cow is treated as a unit, whether she has been in the herd one or more years.

TABLE VIII.—*Comparison of breeds, University dairy herd, 1905-6.*

	Jersey.	Guernsey.	Holstein.	Shorthorn.	Red Polled.	Brown. Swiss.
Number of cows included....	7	7	7	3	4	2
Average weight of cows, lbs..	965	971	1,168	1,242	1,150	1,180
Average age of cows, years ..	7.3	5.6	6.4	12	8	10
Days in milk during year....	325	339	308	263	326	292
Yield of milk, pounds........	6,247.7	6,461.1	10,176.4	4,967.7	7,712.3	6,954.3
Yield of fat, pounds..........	318.46	306.56	346.34	185.36	300.07	275.19
Average per cent fat..........	5.10	4.74	3.40	3.73	3.89	3.96
Average value of products ...	$81 78	$79 27	$93 01	$49 23	$79 31	$72 55
Average cost of feed..........	38 68	37 61	43 29	30 79	37 96	35 56
Average net profit	43 10	41 66	49 72	18 44	41 35	36 99
Average net profit, 1898–1906..	$42 26	$40 74	$46 89	$34 44	$37 68	$28 50

The relatively small number of cows in each breed and the consequent importance of individual differences in these cows are features that should be kept in mind in considering the results given in the preceding table. The following discussion of the results, for this reason, applies only to the representatives of the various breeds in our herd and does not necessarily indicate in general the relative merits of the breeds. It is believed, however, that the average results given in the table form a valuable contribution to discussions on these points. The average data presented show that, on the basis of the records made last year, the different breeds rank in the following order:—

In production of milk: Holstein, Red Polls, Brown Swiss, Guernsey, Jersey, and Shorthorn.

In production of butter fat: Holstein, Jersey, Guernsey, Red Polls, Brown Swiss, Shorthorn.

In cost of feed: Shorthorn (lowest), Brown Swiss, Guernsey, Red Polls, Jersey, and Holstein (highest).

In average net profit: Holstein, Jersey, Guernsey, Red Polls, Brown Swiss, Shorthorn.

In average net profit, 1898-1906: Holstein, Jersey, Guernsey, Red Polls, Shorthorn, Brown Swiss.

Only two points in the preceding table are deemed of sufficient importance at this time to call for further discussion; viz, *first,* the relatively poor showing of the Guernseys, one of the recognized and best dairy breeds in our country; and, *second,* the poor showing of the Shorthorn cows, both as regards production and net profit returned.

As regards the records of the Guernseys, it should be remembered that two heifers were included among the cows of this breed, and that the production of another cow was quite low, owing to the fact that she was far advanced in her lactation period at the beginning of the year here considered and freshened only two months prior to the end of the year. It will be noted from Table III that three Guernsey cows which produced from 368 to 388 pounds of butter fat a year, are found among the best nine cows in the herd during the past year.

Second, as to the records made by the Shorthorns last year, we notice that the herd was represented by only three cows; of these, two have been in the herd for six and seven years, respectively, and, as previously stated, are now both thirteen years old. The third Shorthorn cow, Julia, produced only 229 pounds of butter fat and returned a net profit of $26.38, ranking twenty-fifth in the herd last year.

The Red Polls were able to make a creditable showing last year, both as regards production of butter fat and net profit returned, on account of the excellent record of Lady and the good record of Topsy. The two other representatives of this breed, as already mentioned, were among the poorest ones in the herd and will never make satisfactory dairy cows.

SUMMARY DATA FOR BREED REPRESENTATIVES IN UNIVERSITY DAIRY HERD, 1898–1906.

The following table shows the average production of butter fat and the net profit yielded by the representatives of the various breeds in our dairy herd, as well as their respective rank for the four periods for which summary data have been published since the establishment of the present dairy herd in 1898.

TABLE IX.—*Comparison of breeds, University dairy herd, 1898-1906.*

	1898-1903.			1903-1904.			1904-1905.			1905-1906.			Average, 1898-1906.	
	Number of cows.	Butter fat.	Net profit.	Number of cows.	Butter fat.	Net profit.	Number of cows.	Butter fat.	Net profit.	Number of cows.	Butter fat.	Net profit.	Butter fat.	Net profit.
		Lbs.			Lbs.			Lbs.			Lbs.		Lbs.	
Jersey	12	301	$41.88	5	329	$41.94	6	316	$12.33	7	318	$43.10	312.6	$42.26
Rank	....	3	3	....	2	4	....	1	1	....	2	2	2	2
Guernsey	9	319	44.93	5	290	42.14	9	271	35.06	7	307	41.66	297.0	40.74
Rank	....	2	2	....	4	3	....	5	4	....	3	3	3	3
Holstein	5	352	48.47	5	369	57.10	7	296	35.62	7	346	49.72	337.5	46.89
Rank	....	1	1	....	1	1	....	2	3	....	1	1	1	1
Shorthorn	11	282	36.09	5	310	49.50	6	235	26.88	3	185	18.44	264.7	34.44
Rank	....	4	4	....	3	2	....	6	6	....	6	6	6	6
Red Polled	1	....	....	1	....	....	4	291	34.00	4	300	41.35	295.5	37.68
Rank	....	....	....	....	....	....	....	3	5	....	4	4	4	5
Brown Swiss	....	....	....	....	....	....	2	281	40 00	2	275	36.99	278.0	38.50
Rank....	....	....	....	....	....	....	....	4	2	....	5	5	5	4

We note from this table that the Holstein cows in our herd have in all periods but one (1904–1905), ranked first among the breeds in production of butter fat and in net profit returned above the cost of the feed eaten; when the general results for the four periods considered are calculated, as shown in the last two columns of the table, it will be seen that the Holstein cows likewise lead with an average annual production of 337.5 pounds of butter fat, and a net profit of $46.89, the representatives of the other breeds following in this order: Jersey (production of butter fat, 312.6 pounds; net profit, $42.26); Guernsey (297.0 pounds; $40.74); Brown Swiss (278.0 pounds; $38.50); Red Polls (295.5 pounds; $37.68); and

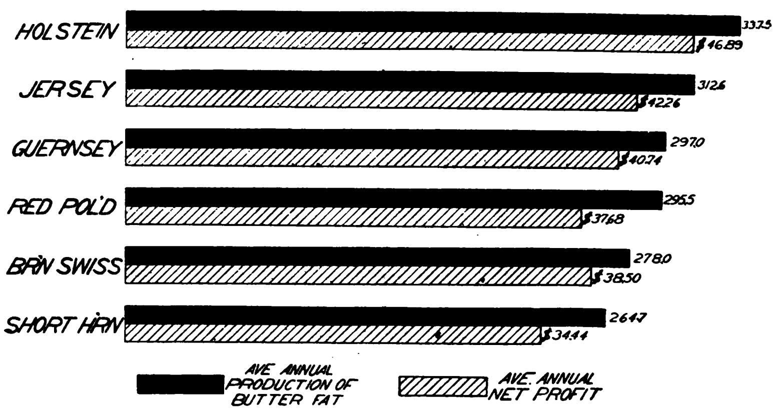


Fig. 8.—Diagram showing relative rank of cows of the various breeds in the University dairy herd, 1898-1906.

Shorthorns (264.7 pounds; $34.44). The average data for the Red Polls and Brown Swiss cows cover records for the last two years, and only for a small number of cows, and are, therefore, of somewhat lower value than the corresponding data for the representatives of the four other breeds, for which records for a larger number of cows are at hand since the year 1898. The average annual production of butter fat and net profits returned by the representatives of each breed are shown graphically in Fig. 8.

DUAL-PURPOSE VERSUS DAIRY BREEDS.

According to the average results of the data obtained for our herd for the period 1898–1906, the three dairy breeds proper, therefore, rank first, and the three so-called dual-purpose breeds come last, both as regards average production of butter fat and net profit returned. The figures presented in the table give decided evidence on this point, and emphasize the fact that cows of breeds that have long been bred and developed with a sole view toward a large and economical dairy production, are the most profitable for a dairy herd. We are fully aware that the records of our dairy herd have furnished a number of exceptions to this general rule; in fact, the cow Lady of the Red Poll breed, which is generally recognized as a dual-purpose breed, has ranked first, both in annual production of butter fat and in net profit yielded, during every year but two since she was placed in our herd; and the Shorthorn cow Rose held the same position in the herd during the first year after it was established; but other representatives of these breeds in our herd have proved wholly incapable of profitable dairy production. We believe that the average records for the cows of these two breeds which have been obtained in our dairy herd in the past do not do an injustice to these breeds in general, but, on the contrary, make a more creditable showing with regard to their capacity for profitable dairy production than they are entitled to when the average production of cows of these breeds in this or other states of the Union is considered.

During the past five or six years quite a marked change has taken place in this country in the practice of breeders of dual-purpose cattle; the maintenance and development of the dairy capacity of their cows have, almost without an exception, been neglected, either systematically for the sake of improving the beef qualities of their animals, or inadvertently through the use of sires whose breeding has been entirely along beef lines. This change has come largely through the competition of breeders of special-purpose beef cattle; the market demands a better grade of beef cattle than formerly, and discriminates against the

common grades of cattle marketed for beef purposes. The capacity of cows for profitable dairy production has, as a result, been gradually reduced, and, at the present time, we find it practically impossible to secure cows of marked capacity for dairy production among these breeds, like, *e. g.,* our own cows Rose and Lady.

In view of the changed conditions that confront the American farmer with regard to the breeding of special-purpose cattle and the demands for meat-producing animals of great excellence, as well as for dairy animals capable of a large and economical dairy production, we cannot recommend the perpetuation of the dual-purpose breeds for two purposes; it is possible by careful and judicious breeding to change them to a special-purpose breed, either a dairy breed or a beef breed, but excellence in either direction cannot be reached except by uninterrupted breeding toward one specific end for many generations: *i. e.,* the dual-purpose must be changed to a single-purpose, which cannot be accomplished with the development of a single or even a few generations. It is evident that, in the case of breeds which have been developed with a view toward dairy production for centuries back, their capacity in this direction has been established to a higher degree and with considerably more certainty than is the case with the dual-purpose cattle, in whose breeding the two purposes have been more or less intermingled. For this reason we believe it will be the part of wisdom for dairy farmers to adhere to some one of the specific dairy breeds in the management of their dairies, and for producers of beef cattle to choose one of the improved beef breeds.

If the views stated in the preceding are correct, breeders' associations and individual farmers who champion the cause of dual-purpose cattle will do well to bend their energies toward the development of their cattle in one specific direction, either toward beef or milk production, according to which of these tendencies seems to predominate. A change in this direction, away from dual-purpose breeding, has doubtless taken place quietly among many farmers and breeders during the past few years in this and other central states, and, if our interpretation of the facts is correct, the development will continue as stated,

until the alluring theory of a double-purpose system of breeding can no longer find adherents among our farmers.

FUTURE CONDUCT OF THE UNIVERSITY DAIRY HERD.

For the reason stated in the preceding, we have in the conduct of our University dairy herd, in a measure, been forced to eliminate the dual-purpose breeds from the herd, and it is our plan in the future to include in the herd only representatives of the four recognized dairy breeds, Jersey, Guernsey, Holstein, and Ayrshires, in addition to Brown Swiss. The Brown Swiss breed cannot properly be classed with the Red Polls and Shorthorns, since their development has been more along the line of dairy than beef production, and they are generally looked upon as a dairy breed. Only two representatives of this breed have been in our dairy herd for the brief period of two years, and we do not feel that results obtained under these conditions furnish a fair basis for determining the value of this breed for dairy production. It is our plan to secure further evidence in the future as to the value of this breed for dairy purposes, although, on account of the relatively small importance of the breed in our country, they cannot properly be placed on an equal footing with the other breeds as regards the number of representatives in the herd.

COMPOSITION OF FEEDING STUFFS FED TO THE HERD, 1905–1906.

The following table gives the results of the chemical analyses of the various feeding stuffs which were fed to the herd during the past year. The corn silage was, as a rule, sampled every other week during the winter for determinations of dry matter, and the dry samples were kept until the end of the period, when a composite sample of these was taken for complete chemical analysis. The other feeds were sampled every time a new supply was received at the dairy barn. The digestion coefficients of the various feeding stuffs published by Jordan have been used in the calculation of the digestible components of the feeds.

TABLE X.—*Average composition of feeding stuffs fed to the University dairy herd, 1905–1906, in per cent.*

	Corn silage.	Mixed hay.	Alfalfa hay.	Wheat bran.	Corn.	Oats.	Oil meal.	Cotton seed meal.	Distillers' grains.	Gluten meal.
Moisture	70.30	10.66	6.24	11.84	15.61	12.25	8.97	6.41	5.58	9.46
Ether extract	.84	1.21	1.83	3.63	3.13	3.91	7.19	8.42	13.61	2.34
Crude protein	2.55	9 94	11.88	14.50	8.72	10.13	33.75	38.38	32.91	30.50
Fiber	5.82	36 26	29.14	12.14	1.83	14.83	8.38	9.15	13.67	2.50
Nitrogen free extract	18.84	35.71	43.09	51.33	69.38	55.80	35.93	30.94	31.87	53.41
Ash	1.65	6.22	7.82	6.56	1.33	3.08	5.78	6.70	2.36	1.79
Dry matter	29.7	89.3	93.8	88.2	84.4	87.8	91.0	93.6	94.4	90.5
Digestible protein	1.3	5.7	8.4	11.5	6.6	7.8	30.0	33.8	24.4	27.1
Digestible carbohydrates and fat	18.2	46.1	41.0	43.7	71.6	52.5	42.0	40.4	62.8	54.6
Nutritive ratio, 1:	14.0	8.1	4.9	3.8	10.8	6.7	1.4	1.2	2.6	2.0

WINTER RATIONS FED TO COWS, 1905–1906.

The winter period here considered began November 17, 1905, and continued for six months. A careful study of the relation of the feed eaten by the cows to their production during this period has been made as in previous years. Thirty cows completed records for the last winter period, with the average results shown in the following table. Information is given in this table in regard to the main facts connected with the production of the cows and their feed consumption during the winter period, viz., number of days from calving at the beginning of the winter period, the period when the cows were dry, days in milk, live weight, composition of the rations fed, average grain fed per day, and the average production of milk and butter fat for each day of the winter period.

TABLE XI.—*Average winter rations fed to cows in University dairy herd, 1905–1906.*

	Days from calving, Nov. 15.	Dry during winter period.	Days in milk, Nov. 15–May 16.	Live weight.	RATIONS FED.				Average grain per day.	AVERAGE DAILY PRODUCTION.			DRY MATTER AND DIGESTIBLE PROTEIN CONSUMED PER POUND OF BUTTER FAT.	
					Dry matter.	Digestible protein.	Digestible carbohydrates and fat.	Nutritive ratio.		Milk.	Butter fat.		Dry matter.	Digestible protein
				Lbs.	Lbs.	Lbs.	Lbs.		Lbs.	Lbs.	Per ct.	Lbs.	Lbs.	Lbs.
Johanna	Dry.	Nov. 15–Dec. 7	160	1,217	27.31	3.00	15.30	1:5.1	11.9	45.6	3.62	1.65	16.5	1.82
Macella	52	....	182	1,002	24.94	3.15	13.89	1:4.4	12.4	27.8	5.87	1.63	15.3	1.93
Maggie	38	....	182	1,301	27.73	3.21	15.64	1:4.9	13.1	46.7	3.38	1.58	17.6	2.03
Jeweletta	Dry.	Nov. 15–Dec. 7	160	1,004	21 82	2.39	12.16	1:5.1	9.7	31.0	4.55	1.41	15.5	1.69
Double Time	62	....	182	1,021	23.45	2 68	13 51	1:5.0	10.2	29.7	4.58	1.36	17.2	1.97
Maxie	Dry.	Nov. 15–Dec. 9	158	1,028	25.32	2.69	14.21	1:5.3	9.7	40.5	2.94	1.19	21.3	2.27
McGeoch	Dry.	Nov. 15–Jan. 10	126	1,403	21.22	2.10	12.15	1:5.8	7.8	29.8	3.82	1 14	18.6	1 84
Perchance	50	....	182	993	21.62	2.46	12 34	1:5.0	8.0	22.8	4.43	1.01	21.4	2.44
Broadway	263	....	182	979	18 62	2.03	10.57	1:5.2	6.7	14.5	6.34	.92	20.2	2.21
Lady	250	Jan. 31–Mar. 21	133	1,254	22.27	1.96	12.86	1:6.6	6.2	22.3	3.90	.87	25.6	2.25
Dorine	170	....	182	1,112	19.49	1.80	11.43	1:6.4	5.0	14 9	5.71	.85	22.9	2.12
Floradora	199	Apr. 6–May 3	155	1,144	19.36	1.84	11.11	1:6.0	6.1	13.7	5.69	.78	24.8	2.36
Artis	227	Mar. 6–Apr. 8	149	1,071	21.01	1.92	12.25	1:6.4	6.1	18.0	4.22	.76	27.6	2.53
Topsy	215	Mar. 26–May 1	146	1,253	20.24	1.91	11.70	1:6.1	5.2	15.7	4.33	.68	29.8	2.81
Cozie	340	Jan. 18–Mar. 17	124	1,019	16.69	1.45	9.63	1:6.6	4.3	11.6	5.78	.67	24.9	2.16
Just in Time	150	....	182	824	17.19	1.35	10.11	1:7.5	6.1	12.0	5.42	.65	26.4	2.08
Joe	225	Feb. 24–Apr. 27	120	1,235	21.00	1.78	12 16	1:6.8	5.1	17.2	3.72	.64	32.8	2.78
Alma	232	Jan. 12–Mar. 12	123	1,149	21.26	1.91	12.25	1:6.4	5.7	20.4	3.04	.62	34.3	3.08
Lily	267	....	182	1,084	17.92	1.77	10.26	1:5.8	7.7	16.0	3.81	.61	29.4	2.90
Mary	172	....	182	919	16.88	1.46	9.77	1:6.7	3.8	10.8	5.28	.57	29.6	2.56
Brownie	326	Mar. 27–May 2	146	1,133	17.96	1.61	10.46	1:6.5	4.3	9.5	5.90	.56	32.1	2.87
Gyp	201	Mar. 27–May 6	142	863	15.98	1.31	9,24	1:7.1	3.6	9.4	5.32	.50	32.0	2.62
Julia	424	....	182	1,437	19.46	1.47	11.45	1:7.8	3.0	13.9	3.60	.50	38.9	2.94
Atilla	269	Jan. 6–Mar. 27	102	1,113	17.67	1.46	10.11	1:6.9	3.6	11.7	4.19	.49	36.1	2.98
Clara	274	Feb. 13–Apr. 19	117	1,348	19.60	1.54	11.36	1:7.4	3.9	11.1	4.23	.47	41.7	3.28
Celia	171	....	182	1,282	18.07	1.38	10.59	1:7.7	2.8	10.9	4.04	.44	41.1	3.14
Lina	235	Feb. 23–Apr. 23	123	1,073	16.14	1.67	9.28	1:5.6	5.4	9.0	4.11	.37	43.6	4.51
Campbell	Dry.	Nov. 15–Mar. 17	60	1,194	15.14	1.13	8.69	1:7.7	2.7	8.7	3.68	.32	47.3	3.53
Maud	447	Feb. 23–May 16	100	1,255	18.15	1.39	10.55	1:7.6	2.9	6.8	4.26	.29	62.6	4.79
Laura	408	Jan. 31–Apr. 26	97	1,040	16.17	1.18	9.39	1:8.0	2.4	5.3	4.90	.26	62.2	4.54
Average (30 cows)	227*	....	148	1,125	19.99	1.90	11.48	1:6.0	6.2	18.6	4.26	.793	25.2	2.40

*5 cows dry.

DISCUSSION OF WINTER RATIONS.

The data given in the preceding table show that the cows in milk in our herd were far advanced in their lactation at the beginning of the winter period, viz, an average of 227 days, and five cows were dry at that time. The cows gave milk 148 days, on the average, during the winter and produced an average of 18.6 pounds of milk and .793 pounds of butter fat per day per head. The average rations fed contained 19.99 pounds of dry matter, 1.90 pounds of digestible protein, and 11.48 pounds of digestible carbohydrates and fat, its nutritive ratio being 1:6.

The changes in the weights of the cows during the winter period have been given in the discussion of the yearly records (p. 71); as shown in the table, there were only ten cows whose weights were not affected by parturition, of which five gained weight and five lost weight. The average gain in weight of the former cows was 21 pounds, and the average loss of the latter, 41 pounds; so that so far as we are able to judge, these cows, on the average, lost somewhat in weight during the winter period. It is not believed, however, that the same relation held true in general for the whole herd; the influence of the parturition of most of the cows either before, during, or directly after the winter period, makes it impossible to arrive at definite information on this point, but careful inspections of the herd during the progress of the winter period led to the conclusion that the system of feeding was conducted so that, on the whole, the cows remained at about their normal weight. The weights of individual cows may be seen on page 71, which should be studied in connection with the data and discussions relating to the production of the cows given in this article.

RELATION OF CHARACTER OF RATIONS FED TO PRODUCTION.

As already suggested, there was a great difference among the cows as regards the stage of lactation at the beginning of the last winter period. Five cows were dry at that time and the

others had been in milk from one to fifteen months, the average period from last calving being 227 days for these cows. Three cows freshened in December and one in January, while the others freshened in the spring. The winter period, in the case of these cows, included the time when their production had ceased prior to the time of calving. As a result there was a wide variation in the average rations fed to the cows; viz., in dry matter, from 15.14 pounds (Campbell), to 27.31 pounds (Johanna); in digestible protein, from 1.13 pounds (Campbell) to 3.25 pounds (Maggie), and in the nutritive ratios of the rations, from 1:8.0 (Laura) to 1:4.4 (Macella). Ten cows received less than 1.5 pounds of digestible protein per day on the average for the entire winter period, and nine received an average of more than 2 pounds of digestible protein per day.

By comparing the figures showing the composition of the average winter rations fed the cows with those given in the last column of the table, it will be noted that, in general, a large amount of dry matter or digestible protein, and a narrow nutritive ratio is accompanied by a high production, and *vice versa; e. g.,* Laura produced only .26 of a pound of butter fat and Campbell .32 of a pound, on the average, per day for the whole winter period, while Macella and Maggie produced 1.63 and 1.58 pounds, respectively. This fact is brought out in a striking manner in the chart, Fig. 9, showing the relation of the production of butter fat by the various cows (dotted line, A), to the pounds of dry matter eaten (B). The chart also shows the relation between A and the per cent. (not pounds, as given on chart) of digestible protein in the rations fed (C) and pounds of dry matter per pound of fat (D). The curve C is obtained from the reciprocals of the nutritive ratios of the average winter rations fed the cows. It will be noted that a high production of butter fat is, in general, accompanied by a large amount of dry matter eaten, a high percentage of protein in the rations fed (i. e., relatively narrow nutritive ratios) and a low figure for dry matter per pound of fat produced, and *vice versa.* The economy of large producers is, therefore, well illustrated by our results, as is also the fact that cows should be

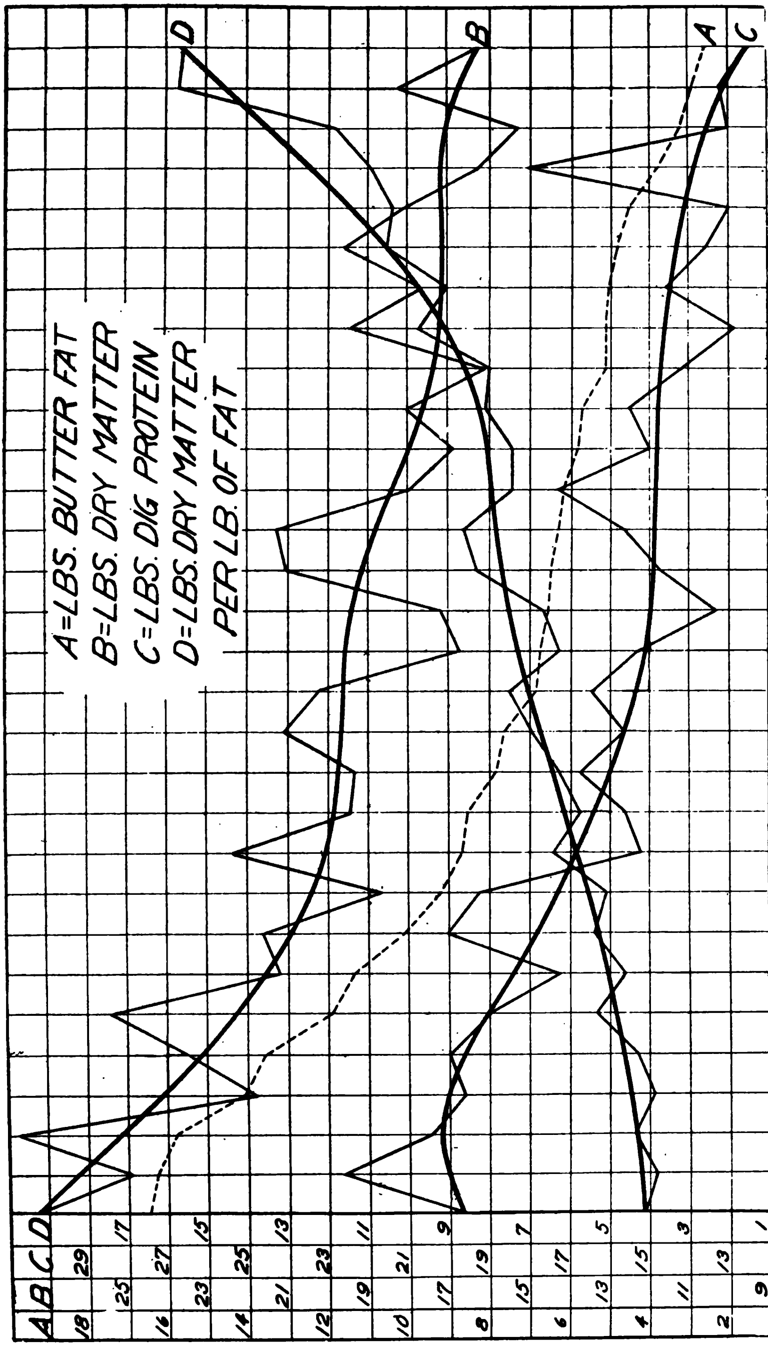


Fig. 9.—Diagram showing the relation between the production of butter fat, the dry matter eaten, the percentage (not pounds) of digestible protein in the rations, and the dry matter per pound of butter fat, for cows in the University dairy herd, winter period, 1905-1906.

fed according to their productive capacities. The principle of feeding according to the production of the cows is one of prime importance in economical dairying and has always been adhered to the management of our University dairy herd.

The amount of digestible protein fed the two cows Campbell and Laura may seem abnormally low for dairy cows in milk, but it was apparently sufficient to meet the requirements of the cows for maintenance of body weight and for the small production of milk solids with which they are credited. On the other hand, some of the high producers in the herd, especially Maggie, Macella, and Johanna, received over 3 pounds of digestible protein per head daily for the entire winter period. Eight cows were fed a narrower nutritive ratio than 1:5.4, the average for the whole herd being 1:6.0. Investigations at our own and other experiment stations have indicated that this is a somewhat narrower average nutritive ratio than will be found most profitable under the conditions prevailing in the north-central states, and this system of feeding our dairy herd has been practiced during the past three years, not because it was supposed to be the best and most economical one under our conditions, but for the special purpose of studying the effect of feeding rather narrow nutritive ratios on the dairy production of the cows. It is not intended at this time to draw general conclusions as to the general economy of the system, or to recommend its adoption by our dairy farmers. Our purpose is next season to again feed our dairy cows rations of somewhat wider nutritive ratios than have been fed during the past three years, using for this purpose rations the concentrates of which will be composed mainly of farm grains and mill feeds.

The average rations fed to the cows in our herd during the winter period of 1904–1905 are given in our Twenty-Second Annual Report. By comparing the data given on page 102 of that report with those in the preceding table, it will be noted that the rations fed last year were, on the average, somewhat narrower, and the average production of the cows was slightly higher than during the preceding winter period. As there were a number of changes of the cows in the herd during these

two periods, comparisons of the average data for these periods are not as valuable as if the results of only those cows be considered that were in the herd both periods. Such comparisons for twenty-seven cows are presented in the following table which also includes similar results for nine cows for a series of four winter periods, 1902–1906, and for eighteen cows for a series for three winter periods, 1903–1906.

TABLE XII. —*Comparisons of winter periods, University dairy herd, 1902–1906.*

	NINE COWS				EIGHTEEN COWS			TWENTY-SEVEN COWS.	
	1902-1903.	1903-1904.	1904-1905.	1905-1906.	1903-1904.	1904-1905.	1905-1906.	1904-1905.	1905-1906.
Average age at beginning of period, years-months	5—8	6—8	7—8	8—8	5—7	6—7	7—7	6—3	7—3
Days from calving	220	227	195	294	200	219	230	209	234
Number of cows dry at beginning of period	1	4	1	2	6	1	2	4	5
Days in milk	150	161	150	121	169	146	143	144	146
Average live weight, pounds	1,070	1,125	1,117	1,197	1,086	1,109	1,187	1,067	1,153
Rations fed, pounds:									
Dry matter	23.69	23.20	21.30	19.18	23.26	20.53	20.17	20.59	20.56
Digestible protein	2.00	2.21	1.94	1.65	2.26	1.78	1.89	1.87	1.96
Digestible carbohydrates and fat	14.10	13.49	12.50	11.10	13.52	12.09	11.63	12.12	11.68
Nutritive ratio	1:7.1	1:6.2	1:6.6	1:6.9	1:6.0	1:6.8	1:6.2	1:6.5	1:6.0
Average grain per day, pounds	7.7	8.6	6.8	4.7	8.3	6.1	5 9	6.5	6.4
Average production:									
Milk, pounds	23.5	23.6	18.6	15.0	21.8	16.9	17.8	18.1	19.4
Fat, pounds	.93	1.00	.77	.62	.94	.72	.76	.759	.817
Fat, per cent	3.96	4.24	4.14	4.11	4.33	4.23	4.26	4.19	4.21
Dry matter:									
Per 100 pounds milk	101.0	98.2	114.3	128.0	106.6	121.3	113.3	113.7	104.7
Per pound fat	25.4	23.2	27.5	31.1	24.6	28.7	26.6	27.1	24.9
Digestible protein:									
Per 100 pounds milk	8.52	9.37	10.40	11.02	10.38	10.53	10.64	10.30	9.62
Per pound fat	2.15	2.21	2.51	2.68	2.40	2.49	2.50	2.46	2.40

Discussions of the average results given in the preceding table will be deferred until further data have been accumulated in regard to the influence of the character of the rations on the production of the cows, especially as to the effect of the nutritive ratio on the economy of the production. Incidentally may be noted the apparent slight tendency of narrow nutritive ratios to raise the percentage of the butter fat in the milk; in the case of comparisons of data for individual cows for different

seasons, or for brief periods of time, no definite tendency in this direction can, as a rule, be traced, but it appears with marked regularity whenever data for a number of cows are considered under conditions that permit of comparison on this point. It is in line with earlier investigations on this point when the fat content of the milk is shown to be influenced by the character of the rations fed to an extent of only a couple of tenths of one per cent at the outside, if the average results for a number of cows are considered. While the advantage of feeding rather nitrogenous rations with respect to the production of milk of a good quality is not, therefore, very pronounced, it should be kept in mind in considering the system of feeding to be adopted in the management of a dairy herd, since an improvement in both quality and quantity is likely to result from feeding as nitrogenous rations as can be done with due regard to the market prices of feeds of different character.

TUBERCULOSIS WORK FOR 1905-1906.

H. L. RUSSELL AND E. G. HASTINGS.

During the last year there has been much activity in the state in the matter of examining herds for tuberculosis. This has come about, in a considerable measure, from the general interest which has been awakened in this question through the medium of the agricultural press. Another most effective factor in this matter has been the demonstration work which has been carried on by the Experiment Station individually, and also in coöperation with the State Live Stock Sanitary Board. In a considerable number of instances, post-mortem demonstrations have been made on cattle which were found to react to the tuberculin test. In this way farmers have had an opportunity to determine the accuracy and efficiency of the test as a means of diagnosis. Wherever such slaughter tests have been made, it has led to a much more extended use of the test. In 1905 a special demonstration of this character was held at the State Fair, which was attended by hundreds of farmers from all portions of the state. Similar demonstrations were made at the Agricultural College in connection with the Farmers' Course.

By these measures many of our more progressive farmers throughout all portions of the state were led to apply the test to their own herds in order to determine their actual condition.

GENERAL PRINCIPLES OF USING THE TUBERCULIN TEST.

The tuberculin test is an exceedingly simple method of determining the condition of the animals in a herd. Any one who

can read a clinical or fever thermometer, and inject the material beneath the skin of the animal can, with a very little practice, make a satisfactory test upon his own herd. It is true that there are conditions which materially affect the accuracy of the test and that in interpreting the results obtained, it is necessary to take these into consideration; but the Experiment Station stands ready to assist the farmer in this way so far as it is within its power.

At the present time it is perhaps not advisable to recommend the use of the test indiscriminately to every one, but there is no valid reason why progressive stock owners cannot easily learn how to apply it on their own herds. In our judgment, this is a most important factor in the problem of controlling bovine tuberculosis. The widespread use of the tuberculin test, especially when buying stock, is an absolute pre-requisite in this matter of control. The test can be so readily applied that we believe much greater good will result from the widespread use of the test in this way, even though there may be a larger percentage of errors than would perhaps occur were the test applied by experts.

In the demonstrations above referred to, the details of application are dwelt upon so that the farmer is taught how to use this test properly. He is asked to follow explicitly the directions which are given as to the management of the herd, the accurate reading of thermometers, and the injection of the tuberculin into the animal. The results are then sent to the Experiment Station for interpretation, and the herd handled on the basis of these results. It is to be expected that some errors will possibly arise from the general use of the test; but if the farmer himself is taught the use of the test, he soon becomes proficient enough in its application to learn how to recognize sources of error. During several years past, tuberculin has been furnished gratuitously and the general character of the tests which have been received have been surprisingly satisfactory.

FURNISHING TUBERCULIN FOR INDIVIDUAL TESTS.

Through the relation which has been established with the United States Department of Agriculture, it is possible for us to secure tuberculin for gratuitous distribution, provided this material is used under strict control. It has, therefore, been customary for us to furnish tuberculin to parties who signified a desire to test their herds, and where we were satisfied that the material, thus furnished free of charge, would be properly used for the advancement of agricultural interests. In doing this the United States authorities and the Experiment Station are desirous of spreading the use of the test, looking to the ultimate eradication of this disease from our herds. We must, therefore, be assured if tuberculin is furnished, that the owner will not only properly use the material, but in case tuberculous animals are found in his herd, that they will be disposed of in such a way as not to endanger other live stock. Moreover, it is absolutely necessary where tuberculosis existed in a herd, that the stables be thoroughly disinfected after the diseased animals have been removed in order to prevent animals subsequently introduced from acquiring the disease. So that applicants may know exactly the conditions under which this material will be furnished, the following agreement is reproduced in this connection.

APPLICATION FOR TUBERCULIN.

Application is hereby made for .... doses of tuberculin for testing .... head of mature animals and ...... head of young stock on the farm of .... of ...., Wisconsin.

No charge will be made for this tuberculin, provided the owner of the herd and the person making the test agree to the following conditions:—

1. The test shall be made within thirty days after the receipt of the tuberculin and the temperature records, made out on blank furnished, sent at once to H. L. Russell, Experiment Station, Madison, Wis., who will report to the owner the results of the test.

2. In case any tuberculous animals are found in the herd, the owner agrees to remove them at once from the healthy portion of the herd, so as to prevent further spread of the disease, and not to sell them to any person except for immediate slaughter. Reacting animals may be disposed of by the state under the rules of the Live Stock Sanitary Board. Address Secretary of the above board, Madison, Wis.

3. In case tuberculous animals are found in the herd, the owner agrees to disinfect thoroughly the stables occupied by the herd.

In making application for tuberculin, state whether you suspect the presence of the disease in your herd. ....

If so, what reason have you for such suspicions?..........

(Signed) ....,
Owner of herd.

(Signed) ....,
Person making test.

RESULTS OBTAINED.

During this past year a much larger number of tests have been made in accordance with the above conditions than have been carried out in previous years. In Table I is presented a summary of the total number of tests made this last year, together with the percentage of animals which were found to react; also those of previous years, in order to show the growth in interest which has recently been taken in this line of work.

TABLE I.—*Summary of tuberculin tests made in Wisconsin under auspices of the Experiment Station.*

	Number of herds tested.	Number of herds showing reactions.	Number of animals tested	Number of animals reacting.	Per cent affected.
1901........	22	10	425	84	19.7
1902........	14	5	306	42	13.7
1903........	11	4	182	5	2.7
1904........	33	13	688	44	6.4
1905........	41	17	726	44	6.0
1906........	....	....	5,781	704	12.0

This does not, by any means, represent all of the tests that have been applied in the state but simply those made directly under the direction of the Station. Those made by the State Veterinarian under the auspices of the Live Stock Sanitary Board show a much higher percentage of affected animals, as only suspected herds are tested by him. From this table, the marked increase in this line of work is at once apparent. The distribution of this work throughout the state has, of course, been far from uniform. Owing to local interest in the matter, widespread use of the test has been made in some counties. A summary of the tests grouped according to counties is shown in Table II.

TABLE II.—*Tuberculin tests for 1905–1906, by counties.*

County.	Number of herds tested.	Number of herds affected.	Number of animals tested.	Number of animals reacting.
Ashland	1	0	16	0
Barron	3	0	24	0
Brown	2	0	22	0
Buffalo	1	1	20	1
Chippewa	2	0	40	0
Clark	4	2	105	5
Columbia	10	2	69	16
Dane	137	99	2,957	509
Dodge	6	1	75	1
Door	1	0	7	0
Dunn	4	1	93	1
Eau Claire	5	1	75	1
Fond du Lac	5	3	113	4
Grant	6	1	93	1
Green	4	1	71	23
Iowa	2	0	26	0
Jackson	3	2	26	3
Jefferson	7	3	149	23
Kenosha	2	1	213	65
La Fayette	2	0	30	0
Manitowoc	5	1	67	1
Marathon	2	0	43	0
Marquette	3	1	36	1
Milwaukee	1	1	27	1
Monroe	2	1	62	1
Outagamie	9	1	180	1
Ozaukee	2	1	13	1
Polk	7	0	104	0
Portage	16	6	143	8
Richland	2	2	17	2
Rock	9	2	135	16
St. Croix	5	1	128	3
Sauk	3	1	68	1
Shawano	1	0	3	0
Sheboygan	1	1	65	4
Trempealeau	1	0	10	0
Walworth	5	1	131	3
Washington	2	0	23	0
Waukesha	12	5	250	26
Waushara	1	1	13	1
Waupaca	5	2	88	3
Winnebago	1	0	2	0
Wood	3	0	10	0

It appears from these data that the employment of the test has been very irregular, although quite widespread throughout the state. Tests have been made in forty-three of the sixty-six counties of the state. In most instances only a few tests have been applied, these usually being on the herds of owners who had been in attendance at the Farmers' Course at the University. In several of the counties a much larger number of tests were made.

In Portage County sixteen herds were examined largely through the influence of one farmer who attended the Farmers' Course and went home enthusiastic on the matter of applying this test. The tests made in Waukesha County resulted largely from an address given before the Wisconsin Dairymens' Association.

Dane County leads all others in the number of tests which have been made. In the course of several tests which were made in the eastern part of the county, it developed that the disease was so widespread that a great many farmers were induced to examine their herds. The details of the work in this region will be referred to later.

It is noteworthy in this work that, aside from the large number of badly infected herds which were found in Dane County, the tests made in other portions of the state did not show, except in occasional instances, a widespread distribution of the disease in many individual herds. In Green, Jefferson, Kenosha, Rock, and Waukesha counties one badly infected herd was found in each case. Twenty-one herds were found in Dane County in which the number of reacting animals approximated 50 per cent. Only one of these herds, however, occurred in portions of the county outside of the Deerfield-Marshall district, to which reference will later be made.

In a very considerable number of cases, reacting animals were found in small numbers, one to two or three cases in a herd. In a larger proportion of instances where it was possible to obtain positive data as to the history of the case in hand, it was found that these sporadic instances of tuberculosis were due to the purchase of affected animals. The detec-

tion of the incipiently diseased condition of these animals prior to the spread of the disease to other members of the herd is a matter of profound moment in the prevention of further spread of this disease.

The beneficial effect of popular demonstrations of the results of the test was shown in a number of instances in this year's work. One case in particular may be mentioned. The superintendent of one of the finest herds in the state attended the Farmers' Course, and became convinced of the advisability of applying the test on the herd under his charge. He had no reason whatever to suspect the presence of the disease, but thought it wise to apply the test on general principles. The herd was a very large one, consisting of over two hundred animals, and when the test was applied, it was found that sixty-six of this number reacted. These were slaughtered under federal inspection, and in a considerable number of cases a badly diseased condition was found. This well illustrates how important it is to apply the test as a matter of general principle, even though no suspicion against the herd exists.

In the case of the six badly diseased herds found in the counties referred to, four of these were owned by extensive breeders from whose herds animals were continually being sold to all parts of the country; one was a milk supply herd in one of the smaller cities of the state; the other, a dairy herd supplying a creamery.

The condition found in Dane County was such as to demand further notice. In the previous tests made under our auspices, as well as those made under the State Veterinarian's, we found in the eastern portion of this county a relatively large number of affected herds. In this year's work, a considerable number of herds were tested by farmers and Short Course students, and it developed that the percentage of reacting animals in the region surrounding Deerfield and Marshall was suspiciously high. Several post-mortem demonstrations were held in this vicinity to awaken a general interest in the matter, and by reason of this an unusually large number of tests were made. With the increased number of tests, it soon became apparent,

from the history of the herds, that the method of distribution was unusual. In two creamery districts, (Oak Park and Medina) the disease was frequently found in young animals which had been raised upon the farms. The animals which had been purchased were the only ones free from the disease. This unusual condition of affairs led to the idea that the skim milk from these creameries might have been instrumental in spreading the disease. By reason of this, it was possible to secure the coöperation of a larger number of farmers than usual. In all 1,213 tests were made in these two districts, in which 374 reacting animals were found. To substantiate this hypothesis, special attempts were made to secure tests upon herds contributory to creameries adjacent to these districts.

In all 1,467 tests were made on herds supplying these outlying creameries, and 127 reactions occurred. This represented 8 per cent of the animals tested, or about the per cent found in the state-at-large, whil in the Oak Park and Medina districts, 30 per cent of all the animals tested were found to be tuberculous.

These facts, together with the history of the individual herds concerned, point conclusively to infection of the skim milk, and the rapid distribution of the disease through the feeding of such infected milk. This method of dispersal is not nearly so common as the spread by purchase of slightly affected stock, but where it becomes operative it greatly increases the rapidity with which the disease spreads. The data obtained in this instance are deemed of sufficient importance to warrant their publication separately as an Experiment Station bulletin.

Many of the more progressive farmers of the state believe that compulsory legislation should be had on the matter of testing cattle; that a law should be passed requiring all cattle owners to have their stock tested so as to determine the condition of their herds and make it possible to eradicate the disease. Such a drastic course of action has been tried in a number of states, notably, Massachusetts and New York, but with poor success. The expense of such a method of procedure is too great; a much more rational method is to spread

the use of the tuberculin test, and have these tests voluntary, rather than compulsory.

If the stock owners of the state would recognize the danger which confronts their industry through the rapid spread of this disease in their herds, they would, of their own accord, determine the condition of their herds. We have continually labored on the theory that an educational propaganda of this character will be much more beneficial in the end and effect the desired result of checking the spread of this disease, rather than to place reliance upon drastic legislative measures.

DEVELOPMENT OF FACTORY DAIRYING IN WISCONSIN.

H. L. RUSSELL AND U. S. BAER.*

It has been customary for this Station at five-year intervals to issue a factory map showing the location of cheese factories and creameries in the state. The first map of this character was published in 1896; the second, on a somewhat larger scale, in 1901, and in Bulletin No. 140 have been recorded similar data as to creameries and cheese factories in operation in 1906. As these records have a definite historical value, especially where comparative studies are made from one period to the next, it has been deemed desirable to give in this connection a brief summary of this study.

In preparing the map for this year, this Station has coöperated with the State Dairy and Food Commission. In the regular inspection work of this Commission, every factory in operation in the state has been visited, and full and definite data secured. The work of locating the position of these factories has devolved upon Mr. U. S. Baer. In studying the dairy development of any region, it must be kept in mind that a numerical map of dairy factories is not an ultimate basis from which to draw definite conclusions as to the growth in dairying, because the factory is not a definite unit of constant value. As shown in Table I, the average number of cows per creamery is much larger than in the case of cheese factories.

* U. S. Baer, Assistant State Dairy and Food Commissioner.

TABLE I—*Dairy statistics from state census* (1905).

Number of creameries reported	926
Total number of cows supplying creameries	595,870
Total number of pounds of milk used	2,046,735,514
Average number of cows per creamery	643
Average number of pounds of milk per creamery	2,210,000
Number of cheese factories reported	1,578
Total number of cows supplying cheese factories	348,817
Total number of pounds of milk used	1,120,205,675
Average number of cows per cheese factory	221
Average number of pounds of milk per cheese factory	710,000

During the last five years there has been a material increase in the total number of dairy factories, although this increase has by no means been uniform with both cheese factories and creameries.

TABLE II.—*Number of dairy factories in 1900 and 1905.*

	1900	1905	Increase.	Decrease.
Cheese factories	1,531	1,649	118	....
Creameries	1,073	1,017	....	56
Combined factories	70	40	....	30
Skimming stations	61	260	199	....
Condensaries	1	3	2	....
Total	2,736	2,969	233	....
Net increase 233				

Creameries.—The number of creameries has fallen from 1,073 in 1900 to 1,017 in 1905, while the number of skimming stations has increased from 61 to 260. This reduction in number of creameries has been brought about by the conversion of a good many creameries into skimming stations. The operating radius of the creamery has thereby been greatly extended, and naturally the average output materially increased, as is indicated by the statistics showing the production of farm and factory butter for the years 1900 and 1905.

TABLE III.—*Amount of butter produced in creameries and on farms.*

	1900	1905	Increase.
	Pounds.	Pounds.	Per cent.
Farm butter	25,000,000	31,500,000	33
Factory butter	55,000,000	88,500,000	60

It is therefore evident that the diminution in number of creameries has not lessened the total butter output.

The introduction of the hand separator has also been a potent factor in increasing the average amount of milk per creamery.

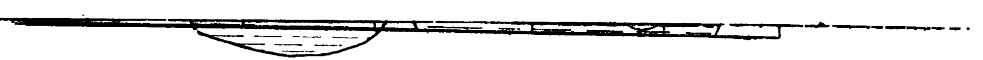
Cheese factories.—In this last half decade the output of cheese has increased from sixty million pounds to nearly one hundred and ten million pounds. The rapid extension of dairying in the newer settled regions of the state accounts for this increase only in part. Even in the older cheese regions there has been a very marked increase in factory development, as is shown by reference to the map reproduced herewith. This map is intended to portray diagrammatically those regions of the state in which there has occurred within the last five years a marked dairy factory development. The group of figures shown in the two columns in each county represents the number of factories of different kinds in operation in 1900 and 1905 respectively. These data are arranged in the following order: 1, cheese factories; 2, creameries; 3, combined cheese and butter factories; 4, skimming stations. Any increase or decrease in the number of factories of any kind can, therefore, be seen at a glance by a comparison of the figures for each of these types of factories.

It must, of course, be understood that *dairy* activity is by no means wholly limited to those regions in which rapid factory growth has occurred, but if we judge of the development of the dairy business on the basis of the erection of creameries and cheese factories, the data here presented show, in a general way, the trend of development which is in progress at the present time. From a study of these data it would appear that there are various sections in which dairy progress is going on at a rapid rate, in which specialization is occurring either in the direction of butter or cheese. The entire state may be divided into two general regions:—

1. Areas of marked factory development which are indicated on the accompanying map by the horizontal lines. The black lines represent, in a general way, marked development in creameries. The red lines show regions in which the number of cheese factories is rapidly increasing.

6. New dairy region of central counties.

Solid black line with narrow hatch lines running from Pepin Co. east to Waupaca, then south and west to La Crosse Co., surrounds the area occupied by the residual sandstones of the Potsdam formation. Factory development in both butter and cheese is much more rapid outside of this region than within it.



2. Areas not yet developed, or in a relatively quiescent condition, so far as factory growth is concerned. These are designated on the map by the absence of the horizontal lines.

I. REGIONS OF ACTIVE DAIRY FACTORY GROWTH.

1. *Swiss cheese region.*—Perhaps the most distinctive, although not the largest, area in the state is that embraced by Green and surrounding counties, in which Swiss and Limburger cheese manufacture has been intensely developed. Within the last five years the number of factories of this character has increased from 183 to 301, and the boundaries of the industry have been extended rapidly to the westward and northward, embracing at the present time all of Green, eastern Lafayette and Iowa, and southwestern Dane County. The aggregate output of this type of foreign cheese at the present time is estimated at approximately 15 million pounds.

2. *Richland County cheddar region.*—Richland County has long been known for the quality of cheese which it has made, and factory growth here has gone on during the last five year period more or less continuously, and is being rapidly extended into all counties contiguous to this county. The cheddar industry is rapidly pushing to the southward, where it will soon meet the Swiss cheese industry above referred to.

3. *Cheddar region of lake-shore and adjacent counties.*—The most extensive cheese region of the state is that which is embraced in the lake-shore and adjacent counties. Over one-third of all of the cheese factories of the state are located in the lake-shore counties north and also west of Milwaukee County, including Fond du Lac, Winnebago, and Outagamie counties. The total number of factories has not materially increased in this region, although the aggregate output is considerably more than that of five years ago.

4. *Brick cheese region of Dodge County.*—Wisconsin is unique in the way in which the foreign cheese industry of the state has developed. Besides the Swiss cheese region of Green County, in nearly all of Dodge County, and to some extent in adjoining counties, another variety of foreign cheese, viz, brick

cheese, is made in large quantities. In Dodge County cheese factories have increased in the last five years from 102 to 128, while the creameries have declined in numbers from 46 to 31.

5. *Butter belt of southeastern Wisconsin.*—Between these eastern and western areas of intensive cheese development, dairying has developed in a large section in which the manufacture of butter is much more marked than that of cheese. This region embraces much of southeastern Wisconsin, having for its center, Jefferson County. It is in reality an extension of the great Elgin district which has been so long famous for the production of butter. The development of dairying has been almost uniformly along the line of butter production, the number of butter factories out-numbering the cheese factories nearly ten to one.

6. *The new dairy region of central Wisconsin.*—This region marks the area in which the greatest change in number of factories is to be observed. With the influx of an agricultural population into the hardwood belt, extending across the state from Green Bay westward, the dairy industry along both butter and cheese lines has been rapidly extended. Table IV shows the factory growth in these counties during the last ten years, in which the number of creameries has been increased nearly three fold, while cheese factories have nearly doubled in number.

TABLE IV.—*Factory development in central Wisconsin, as shown by the progress of the last ten years.*

County.	Cheese.				Creameries.			
	1895.	1900.	1905.	Increase, 10 y'rs.	1895.	1900.	1905.	Increase, 10 y'rs.
Shawano	20	14	56	36	4	6	10	6
Oconto	4	5	17	13	8	10	16	8
Waupaca	30	28	29	−1	3	17	22	19
Portage	3	0	1	−2	0	18	26	26
Wood	14	21	15	1	5	11	20	15
Marathon	13	34	43	30	6	17	21	15
Clark	13	17	27	14	16	15	26	10
Eau Claire	4	4	1	−3	4	6	12	8
Chippewa	10	15	10	0	4	10	29	16
Barron	1	3	7	6	3	11	18	15
	112	141	206	94	53	121	191	138

II. UNDEVELOPED, OR QUIESCENT, REGIONS OF FACTORY GROWTH.

1. *Quiescent factory region.*—A study of the accompanying map shows an area of considerable size in the central and west central portions of the state in which the building of dairy factories seems to have come to a standstill. In the counties of Marquette, Waushara, Sauk, Adams, Juneau, Monroe, La Crosse, Jackson, Trempealeau, Eau Claire, Buffalo, Pepin, and Dunn, the number of cheese factories has declined during the last five years from 106 to 65; the number of creameries from 185 to 170. The decline in butter lines has been compensated for in part by the increase in number of skimming stations from 28 to 59. It appears, however, from these data, that continued factory development has not gone on in this section as it has in those portions of the state previously described. A possible cause for this lack of factory growth may be related to the nature of the soils in this region. The soil map compiled by Professor Whitson and published on page 262 in the Twenty-Second Annual Report of this Station, shows this area to embrace the soils that have been derived principally from the sandstones of the Potsdam formation. On the accompanying map this area is designated by the solid black line running from Pepin County through Dunn, to Waushara County, then southwesterly and westerly to La Crosse County.

The rapid development of factory dairying is conditioned upon the luxuriant growth of forage grains and grasses, and from the way in which this industry has developed during the last decade, it is apparent that the clays and loams of the area immediately north of this section of light soils are much better suited for the more intensive development of the dairy industry.

Besides this central belt referred to, it is also noteworthy that factory growth is going on very slowly indeed in practically all of the counties on the western border of the state. In the eleven counties contiguous to the Mississippi and St. Croix Rivers, there has been no gain, or a positive loss in cheese factories in eight of them, with an aggregate loss of

twenty-two while the net gain in creameries is only nine, or less than one creamery to each county. It should be recorded, however, that in this region the number of cows furnishing milk to creameries is larger than in many other regions, due to the fact that many creameries operate on the gathered cream plan. But even taking into consideration this fact, the quiescent condition, so far as factory growth is concerned, stands in striking contrast to the eastern and southern portions of the state.

2. *Undeveloped areas.*—Naturally the northern counties have not as yet begun to feel much effect from the dairy movement which has been so active in the southern and eastern parts of the state. It is, of course, impossible to tell how far the new dairy belt of north central Wisconsin will be pushed to the northward. Its present confines are stayed merely by lack of settlement. While there are a number of cities of considerable size in the northern tier of counties, these furnish no opportunity for dairy factory development. Unquestionably a large part of this northern area is well adapted to dairying and will develop extensively in this direction, as the soil, climatic, and forage conditions are in a general way similar to the present dairy region immediately adjacent to the southward. Naturally this development will follow the lines of the railways as farming settlement advances, a condition which is already to be noted in Taylor, Lincoln, and Langlade counties. It may confidently be expected that those areas in this region in which the soil is suitable for dairy husbandry, will, in the course of the near future, go forward along the lines in which the state seems destined to develop.

DISTRIBUTION OF LACTOSE-FERMENTING YEASTS IN DAIRY PRODUCTS.

E. G. HASTINGS.

In the Twenty-Second Annual Report of this Station a report was made concerning an abnormal fermentation occurring in Swiss cheese, caused by lactose-fermenting yeasts. A survey of the literature concerning this class of organisms made it evident that little was known as to their distribution and prevalence. It was thought desirable to undertake work along this line to determine whether this group was to be found in all kinds of dairy products, and whether they were sufficiently common to be of any practical importance in abnormal fermentations of butter and cheese.

LITERATURE.

A few saccharomycetes and a number of torulae which are able to ferment milk sugar directly, have been found by other observers. Most of these were discovered accidentally while pursuing other lines of work, as is the case with the organisms found by von Freudenreich and Jensen* in the "Sauer" used in Swiss cheese making, and those found by Jensen† in Swiss butters. Harrison,‡ in his studies concerning bitter cheese, examined, with positive results in nearly every case, a large number of samples of milk, whey, cheese, etc. These were,

*Centbl. Bakt (ect), II Abt., 3 (1897) p. 545.
†Centbl. Bakt (ect), II Abt., 8 (1902) p. 251.
‡Bul. 120, Ontario Agr. Col.

however, all drawn from a single factory, viz, the one in which the trouble, thought to be due to the organism, occurred. It is not evident, from Harrison's work that samples from other sources than the factory in question were examined. The only attempt, known to the writer, to determine the distribution of this type of microbic life is that made by Maze.* Thirteen kinds of cheese were examined for the presence of lactose-fermenting yeasts. Since all but two (Port-du Salut and Emmenthaler) were of the soft type, and since but one cheese of each kind was examined, the results cannot be extended to cover all types of dairy products. In eight of the cheese, lactose-fermenting yeasts were found. While no quantitative determinations were made, it was evident from the qualitative tests that the yeasts were present in such small numbers that they could exert no great influence over the product.

In the various samples of cheese, butter, and milk, examined in the investigation of the trouble described in the last annual report, immense numbers of lactose-fermenting yeasts were found. Some of the samples of the milks showed a decidedly yeasty fermentation when 24 to 48 hours old. Samples of whey were in an active state of fermentation when taken from the vat. The butter prepared from the cream, removed from the whey, was very yeasty in odor and taste. In this factory the yeast seemed to predominate over every other form of microbic life.

During the past year the examination of dairy products for these yeasts has been extended to about 450 samples of milk, cream, butter, cheese, and whey. These samples came from all parts of the state, representing the Swiss and cheddar cheese, as well as the butter industries.

METHODS OF ANALYSIS.

The samples of cheese, milk, whey, etc., were plated on lactose agar to which enough tartaric acid had been added to totally inhibit bacterial growth (1 to 1½ per cent) The various types of colonies to be found on the plates were inoculated into acid whey. These subcultures were incubated for 48 hours

*Ann. Inst. Pasteur, 17 (1903) p. 11.

at 38°C. and were then examined for gas production. If the organism is able to ferment lactose with the formation of alcohol and carbon dioxide, a supersaturated solution of carbon dioxide is formed. As soon as the culture is slightly agitated, gas will be given off in abundance. On account of the amount of work involved in plating out large numbers of butters, a more direct method was used in this examination, the butter being directly inoculated into acid whey. The cultures that showed abundant gas production were classed as positive, *i. e.,* containing lactose-fermenting yeasts.

In the sterilization of whey, it is possible that invert sugar might be produced, and consequently, a source of error introduced. If the lactose, which is contained in the acid whey having an acidity of 1–1.25 per cent of lactic acid, is inverted during the sterilization of the culture medium, dextrose and galactose will be formed; such sugars would then be fermented by the ordinary types of yeasts. That the prevalent idea of the inversion of lactose in acid solutions is not a correct one is shown by Lippmann.* He states that lactose remains unchanged when heated to 100°C. in a 4 per cent solution of oxalic acid for eight hours. Again, samples of the acid whey used have been inoculated with beer yeasts and no fermentation could be noted; hence, it is evident that no appreciable amounts of invert sugar could have been formed from the lactose in the whey.

That there is a source of error in the direct inoculation of the samples into acid whey is shown by the fact that in samples of milks gas production has been noted, due to yeast activity, but from these samples, no organism could be isolated capable of fermenting milk sugar in pure culture. In these milks the lactose has undoubtedly been inverted by the enzyme, lactase, formed by some of the micro-organisms present. The invert sugars were then fermented by other forms of yeasts. This condition is known to exist in some of the alcoholic drinks prepared from milk, such as koumiss and kefir. In some samples of kefir-grains, no lactose-fermenting yeasts were found, (von

*Chemie der Zuckerarten, III Auflage, p. 1550.

Freudenreich) while they were contained in grains examined by another investigator (Beyerinck).

Admitting that there are sources of error in the direct method of inoculating the sample to be examined directly into whey, the method is undoubtedly more delicate than the use of plate cultures, for the amount of material that can be used in a plate culture is limited. The organisms sought may be present in such small numbers as not to be found by plate cultures.

DISTRIBUTION OF YEAST IN THE SWISS CHEESE DISTRICT.

The abnormal fermentation, above referred to, occurred in Swiss cheese, and it was important to determine the general distribution of this type of life in this cheese region.

Samples of milk, whey, rennet solution, butter, and cheese have been examined, these samples representing twenty different factories.

In Table I are given the results obtained from the examination of 51 samples* coming from Swiss factories.

TABLE I.—*Distribution of lactose-fermenting yeast in Swiss cheese factories.*

NUMBER OF SAMPLES EXAMINED.		RESULTS OF EXAMINATION	
		Positive.	Negative.
Milk	8	7	1
Whey	22	21	1
Rennet	4	4	0
Cheese	9	7	2
Butter	8	8	0

One of the negative results was from a sample of whey from which the fat had been removed by the "hot process," by heating to 80°C. (176°F.). This would, of course, destroy all yeast cells present. One cheese, in which no lactose-fermenting yeasts were found, was six weeks old; the other was of un-

*A very large portion of the samples which have been examined in this work were obtained through the courtesy of members of the staff of the State Dairy and Food Commission, for which the thanks of the writer are hereby tendered.

known age. It has previously been shown that yeasts do not persist for any considerable length of time in cheese. It is evident from these results that this type of microbic life is widely distributed in the Swiss cheese district.

DISTRIBUTION IN BRICK CHEESE DISTRICT.

Very similar conditions obtained in the brick cheese district in Dodge County.

TABLE II.—*Distribution of lactose-fermenting yeasts in brick cheese factories.*

NUMBER OF SAMPLES EXAMINED.		RESULTS OF EXAMINATION	
		Positive.	Negative.
Milk	67	59	8
Whey	4	4	0
Cheese	13	5	8

The milk examined represented samples of the milk of individual patrons at three factories where more or less trouble was experienced with abnormal fermentations. The cheese examined were of unknown age.

DISTRIBUTION IN AMERICAN CHEESE FACTORIES.

Samples of whey from eighteen cheddar factories have been examined for the presence of this type of microbic life. The factories were situated in various parts of the state. In every case the presence of the lactose-fermenting yeast was demonstrated.

From each factory a sample of the whey was taken before it was drawn from the curd, and also one from the whey tank. It was thought that the samples taken from the cheese vat might not show this yeast. It has been found, however, in every sample, whether from cheese vat or from the whey tank. No marked difference as to the numbers present in the different samples could be noted. The samples were usually several days old when they were examined; thus, a considerable quan-

titative difference at the time the samples were taken, might be destroyed through subsequent growth.

DISTRIBUTION IN CREAMERY BUTTER.

In July 114 samples of Wisconsin butter were examined, representing as many creameries. Twenty-four of these samples, or 21 per cent, contained lactose-fermenting yeasts. In August 83 samples were examined, these representing, in part, the same creameries as the butter examined in July. In 26 of these, or in 31.3 per cent, this type of yeast was found. Whether this increase of nearly a half is due to summer conditions is not at present clear. The butter examined in July, was made in the latter part of June; the cream and the milk at that time were likely to be of better quality than later. Moreover, lactose-fermenting yeasts are favorably influenced by high temperatures. It is hoped that further work may determine whether there is any increase in this form of life during the summer months over the cooler periods of the year.

The samples of butter examined were made under widely different conditions. No relation could be found to exist between the kind of starter used and the presence of the lactose-fermenting yeast. At least one of the commercial starters on the market is known to contain this type of organism. It could be found, however, in but few of the butters made with this starter.

It was thought that possibly butter made from gathered cream would show the constant presence of this yeast, since a large part of the gathered cream is held for 2 to 4 days before churning. The acidity which would thus develop, uncontrolled, would furnish favorable conditions for the growth of the yeast, in case the cream had been seeded in any way with it. No such relation was found to exist. In fact 70 per cent of the butter which has been entered in the judging contest carried on by the State Dairy and Food Commission contained more or less gathered cream.

The number of yeasts present in the butter was very small. Quantitative examinations were made of a portion of the July

butter in which the yeast had been found. The number present per gram ranged from a few hundred to five thousand. Even butter that was yeasty in flavor contained very few in comparison with the whey butter examined.

The quality of the butter in which the yeasts were found in July and August was superior to the average of all samples entered in the judging contest. In July 73.7 per cent of the butter scored 93 points or better. Of the 17 samples found to contain yeast, over 77 per cent scored 93 or above. In August 73 per cent of the butter containing yeast was graded as "extras," while but 63.7 per cent of the entire lot judged was deemed entitled to this grade. It appears from this that the lactose-fermenting yeasts, in the numbers in which they occurred in the butter examined, exerted apparently no injurious effect on the quality of the product. Undoubtedly, in the case of whey butter, this factor is of considerable importance in determining the quality of the product.

Besides the samples enumerated, 67 others have been examined. Thirty-eight of these were from milk of individual patrons of the University dairy. In May, 1905, twenty samples were taken and seven found to contain this type of organism. In June, 1906, eighteen samples were taken and fifteen of these gave positive results.

A portion of the other samples examined were from milk taken from individual herds in other states. In but two of these could this type of yeast be found, viz, one from Ames, Iowa, and one from Stillwater, Oklahoma. In Table III are summarized the results of the examination of these miscellaneous samples.

TABLE III.—*Distribution of lactose-fermenting yeasts in dairy products.*

NUMBER OF SAMPLES EXAMINED.		RESULTS OF EXAMINATION	
		Positive.	Negative.
Milk	51	29	22
Cream	4	3	1
Whey	2	2	....
Butter	3	1	2
Cheese	4	....	4
Starter	3	....	3

The results obtained from the examination of the various samples show that lactose-fermenting yeasts are widely distributed.

SIGNIFICANCE OF LATOSE-FERMENTING YEAST IN DAIRYING.

Hansen, in his work on the occurrence of yeasts, both saccharomycetes and torulae, has shown that there are primary and secondary sources of yeasts. The first, for the type able to ferment fruit sugar, are fruits that have been injured, thus giving the organism access to a liquid rich in nutrient material, and in which rapid cell proliferation takes place. These primary sources have in the past been considered of great importance, but later work has shown that they are of less importance than the so-called secondary sources, which are to be found in the soil proper, and wherever dirt accumulates and is protected from desiccation. The organism, in such places, is able to grow in the extract from decaying organic matter. Such places as these are, of course, multitudinous and although growth is slow, yet it is here that yeast life is able to perpetuate itself.

The habitat of the lactose-fermenting yeasts is undoubtedly similar to what Hansen calls the secondary sources of the more common forms. Harrison* found a yeast of this type on the leaves of certain maples. This was undoubtedly an accident, the organism having been borne there in the dust.

The question is simply one of the ecology of micro-organisms. Whenever these forms, carried by the wind, insects, etc., gain entrance to a place where proper nutrient material is abundant and constant, rapid growth takes place. This is the condition we find in cheese factories; the open whey vat with its content of more or less acid whey is a most favorable environment for this type of yeast. In case the whey is returned to the farms in the same cans in which the milk is carried, the milk will undoubtedly become contaminated to a greater or less extent. Whether this contamination is of marked importance or not depends upon the type of the industry.

Under creamery conditions, in case the starter is propagated

*loc. cit.

as it should be, there is little or no opportunity for infection. The skim milk in this case is carried back to the farm in practically the same condition as it was when it reached the creamery. The yeast found in butters are thus purely adventitious forms.

In the cheddar industry, while the whey may contain considerable numbers of this form of yeast, yet in competition with the lactic acid organisms that develop so luxuriantly in this habitat they are not able to hold their own. Proliferation of yeasts is slow compared with that of bacteria, and before any marked increase in numbers can take place, the sugar has been used up by the lactic acid forms. It is only in certain branches of the industry that this type of yeast is likely to become at all dangerous. In the Swiss cheese industry, on account of methods of manufacture and certain practices, they are much more certain to be of economic importance. Since our attention has been specially directed toward this type of microbic life, several outbreaks in Swiss and brick cheese factories have come to light that have been traced directly to this kind of infection.

The chance for infection here is much greater than in cheddar cheese making, due to the methods of whey disposal, and the use of solutions of whey-soaked rennets. Again, in this type of cheese, the yeast does not come into such sharp competition with lactic acid organisms, the cheese being made from milk as sweet as possible.

A LABORATORY INCUBATOR.

E. G. HASTINGS.

No other class of bacteriological laboratory apparatus involves so large an expenditure as the incubators. Especially is this true where large classes of students must be provided with incubator facilities, or where, on account of the nature of the work, a large amount of space is desired.

If new buildings are to be constructed for bacteriological work, it is a simple matter to install permanent insulated rooms provided with heating facilities. When, however, a building must be adapted for work in bacteriology, the construction of rooms is more or less troublesome and of considerable expense.

During the past year the Bacteriological Department of the College of Agriculture has used an incubator which, on account of its cheapness and efficiency would seem to be well adapted for more general use, hence this description. A refrigerator of regular stock size was used for providing the insulated space necessary. To adapt it to incubator purposes, a hole was cut in one end near the bottom for the entrance of the heating pipe, a smaller hole in the top for the exit pipe, and two small holes for the gas pipes to and from the regulator. The racks and drip pan were removed from the ice chamber, and shelves substituted to correspond to the other parts of the incubator. The changes were easily made as the lining was of soft wood. The interior of the refrigerator was painted with four coats of white lead and one coat of enamel paint. The size of the incubator, illustrated in Fig. 10, is 58 inches wide, 30½ inches deep, and 74 inches high. The total shelf space is slightly over 33 square

feet, *not including the bottom, which can be used in part. The shelves can easily be removed if vessels of considerable height are to be placed in the incubator.

Fig. 10.—A laboratory incubator adapted from a refrigerator.

The method of heating is the same as was first used for the heating of incubator rooms, by Dr. Salomonsen of Copenhagen, and, later, by Dr. Tavel and Dr. Ed. von Freudenreich of

*A part of the shelves were removed from the lower compartment when the photograph was taken.

Berne, Switzerland. The heating pipe used is 2 inch black iron, threaded and screwed together rather loosely. A 1 inch vertical pipe passes through the top of the incubator. The flame burns in a short vertical pipe outside the incubator; the pipes inside are nearly horizontal, a very slight rise being given to aid in circulation. The pipe provides about 5 square feet of heating surface; that this is sufficient is shown by the fact that the gases discharged at the outlet have nearly the same temperature as the interior of the incubator, thus showing that practically all the heat is utilized. Where the pipe passes through the wall of the incubator, a piece of asbestos steam pipe packing is used in order to protect the wood.

The thermo-regulator used is of the Roux type with horseshoe shaped bar. This is placed in a permanent line of pipe, short pieces of lead pipe being inserted at the regulator in order to give flexibility and thus afford easier adjustment of the regulator. The regulator is placed on the left side of the center partition, and therefore is not visible in the illustration. The lamp first used was an ordinary Welsbach burner with the gauze cap but without the mantle. During warm weather this furnished so much heat that it burned so low as to be in danger of being extinguished by slight drafts from open windows. An ordinary micro-Bunsen burner has been substituted for the Welsbach. The temperature can be mainatined within a degree centigrade although the gas pressure varies considerably during the day. The four doors permit access to any part of the incubator without influencing, in a marked degree, the temperature, unless the doors are frequently opened. Naturally a marked reduction in temperature is not regained as quickly as in a waterjacketed incubator. Tubercle cultures have, however, been grown very successfully in it. The temperature of the lower shelves is about 2°C. below that of the upper shelf.

It is desirable to maintain a considerable degree of humidity in an incubator. By placing a pan of water on the heating pipe where it enters the incubator, it is possible to maintain a saturated atmosphere. It was not found practical to do so, however, on account of the condensation around the doors. By

placing the pan on the pipes farther from the entrance of the same, less water is evaporated, and thus the degree of humidity is easily controlled.

The incubator, with regulator and heating apparatus, was installed for about $80.

For student use the incubator could be equipped with drawers, or compartments, so arranged that the fronts of the same would provide an additional closure, thus preventing the cooling in large part where the doors were frequently opened, and furnishing all the facilities of a high priced compartment incubator.

RELATION OF SOIL BACTERIA TO NITROGENOUS DECOMPOSITION.

CONRAD HOFFMANN.

Within the last few years special emphasis has been laid upon the study of soil problems from the biological point of view. Nitrification, the influence of leguminous bacteria upon the fertility of soil, as well as the fixation of atmospheric nitrogen by organisms without the intervention of the green plant, have received the attention of a number of investigators. The nitrifying processes are changes that are connected with the final conversion of proteid matter into plant food. Curiously enough, the initial changes concerned in the breaking down of such compounds have not received in any wise the attention that has been given to the above problems. In the majority of studies relating to decomposition, the changes have been studied from either the chemical or biological point of view only, and not from a bio-chemical standpoint. In this preliminary study attention has been given to both points of view.

In carrying out this work the following objects were kept in view:—

1. To trace the relation between the rate of decomposition and nitrification of various nitrogenous substances, and the germ content of the soils in which these processes occurred.

2. To ascertain the influence of different soil types upon the foregoing changes.

3. To determine the relative susceptibility of different nitrogenous substances to decomposition and nitrification.

Inasmuch as the processes of nitrification diminish the amount of ammonia produced as a result of proteid decomposi-

tion, by converting it to nitrites and nitrates, the method of studying the rate of initial decomposition processes under anaerobic conditions was also attempted. In this way the effect produced by nitrifying aerobic processes was excluded.

TECHNICAL METHODS EMPLOYED.

Inasmuch as this work was preliminary in character, it was deemed advisable to perfect rapid methods which would give results of comparative rather than ultimate accuracy. In the analysis of the material an attempt was made to secure data as to germ, moisture, ammonia, and nitrate content of the soil samples once in two weeks, together with a total nitrogen determination at the beginning and the end of the experiment.

Mode of sampling.—Several different methods were tested before the adoption of the one here described. This method is essentially that which was used by Chester in his soil work. It consists of emptying the contents of each jar upon a sheet of clean paper, and thoroughly mixing the same with a large sterile spatula, taking care to render the mass as homogeneous as possible. After samples of soils were removed from various portions of the mass, a smaller composite sample was taken from the mixture of the first samples selected.

BACTERIOLOGICAL TECHNIQUE.

The technical methods for the determination of the bacterial content of soils have not as yet been thoroughly worked out, as comparatively little study has been placed upon the quantitative examination of soils. A comparison of the two methods usually employed, viz, (1) the direct dilution as used by Hiltner and Störmer* and (2) the trituration method as advocated by Chester† was made with results as tabulated in Table I.

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*Arb. K. Gondhtent., Biol. Abt. Bd. III (1903) Heft 5.
†13th Ann. Rpt. Del. Expt. Sta., 1901.

TABLE I.—*Germ content of soil as determined by the direct dilution versus the trituration method.*

Trial.	Number of bacteria per gram of soil by the—	
	Direct dilution method.	Trituration method.
1.	1,250,000	1,400,000
2.	2,060,000	2,290,000
3.	1,980,000	2,300,000

As shown in the table, the differences between the results obtained are slight and the shorter period of time involved made the direct dilution method more suitable. In this method 0.5 of a gram of soil was accurately weighed under aseptic conditions and added to a 200 cubic centimeter flask containing 100 cubic centimeters of sterile water. After thoroughly shaking, a second dilution in 100 cubic centimeters of sterile water was made in accordance with the usual method. In order to secure plates having between 100 and 200 colonies, it was necessary to make a relatively large number and from these select such plates as contained the proper number of colonies, inasmuch as plates with copious seeding do not give correct results. Cultures were grown for eight days at 18° to 20°C. A careful comparison of results showed that the maximum variation in bacterial content did not exceed 23 per cent and usually was much less.

Composition of medium.—In his early work Chester employed gelatin, but subsequently recommended agar as preferable. Hiltner and Störmer maintain that ordinary alkaline gelatin is more suitable, as this reaction inhibits mold development. It has been found, however, that the alkline reaction prevents the growth of many forms of bacteria as well.

Remy has suggested the use of soil extract gelatin. This is made up in the usual way, but instead of the liter of tap water 500 cubic centimeters of a ten per cent soil extract solution is mixed with 500 cubic centimeters of tap water.

It was found upon testing the culture media that the rapid liquefaction of ordinary gelatin rendered it quite unsuit-

able, and a comparison of a series of culture plates, made with soil extract gelatin and ordinary gelatin with a reaction of 0.5 per cent normal hydrochloric acid, showed that the soil extract medium was much preferable. In making this soil extract, 10 grams of each of the four soils used were mixed with 400 cubic centimeters of water and boiled for thirty minutes. The hot solution was then filtered, alum being used to facilitate clarification. The clear extract was flasked, sterilized, and stored, so that the same lot of culture media could be used throughout the entire experiment. Plates made with the soil extract gelatin gave uniformly a higher germ content than those prepared with the ordinary gelatin, and it was further noted that a marked retarding influence was exerted on the liquefy-

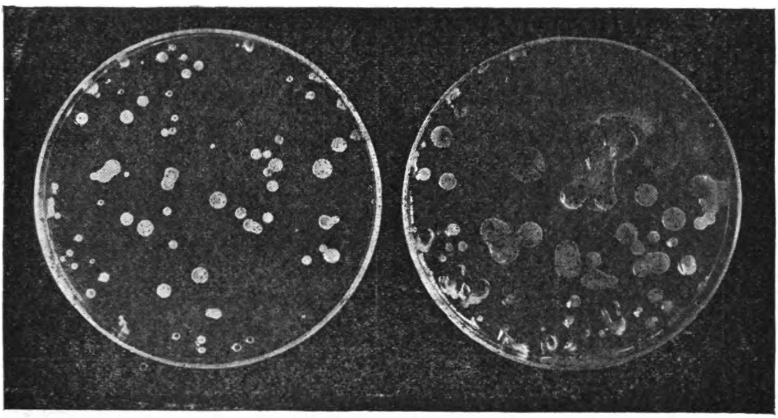

Fig. 11.—Effect of soil extract upon the growth of liquefiers on gelatin. The plates photographed were made under identical conditions, except that in the left plate plain gelatin, and in the right, soil extract gelatin was used.

ing bacteria. Fig. 11 shows this in a striking manner. Several series of plates, made with different liquefiers taken from soil, all showed this difference without exception. So far as the writer has been able to ascertain, this interesting phenomenon has not been previously observed, and it would seem to warrant further investigation, as the inhibition of liquefying organisms in gelatin is a matter of considerable importance. Both media were absolutely identical in composition, except as to the soil extract and the alum, so that the inhibition of

liquefaction must be attributed to either one or the other of these factors. To test this point, soil extract media were made without clarifying with alum. The same results were obtained with this as with the alum-clarified media. Furthermore, the addition of alum to both plain and soil extract gelatin lowers the solidifying point, depending upon the increase of the alum added. A gelatin medium containing two per cent alum remained a viscous liquid at 18°C. It is apparent from this that the alum used in clarifying the soil extract did not inhibit the liquefaction, but that the latter must be attributed to the influence of the soil extract alone.

Reaction of medium.—To determine the influence of reaction, a series of soil extract media were made ranging from 1.5 per cent normal hydrochloric acid to 1 per cent normal hydrate. Germ content determinations were made with these media upon the clay and the sandy loam soils. The results expressed in Table II show that a reaction of 1 per cent normal hydrochloric acid gave the most abundant growth (in numbers) in both soils.

TABLE II.—*Relation of the reaction of the medium to the development of soil bacteria.*

REACTION.	CLAY.	SANDY LOAM.
	Average number of bacteria per 0.5 gram of soil.	Average number of bacteria per 0.5 gram of soil.
1.5 per cent acid	790,000	1,070,000
1.3 per cent acid	1,490,000	1,360,000
1 per cent acid	2,553,000	2,743,000
0.8 per cent acid	2,103,000	1,520,000
0 5 per cent acid	1,680,000	1,520,000
0.3 per cent acid	1,530,000	1,253,000
Neutral	1,093,000	1,376,000
0.5 per cent alkali	1,386,000	1,216,000
0.5 per cent alkali	1,656,000	966,000
0.8 per cent alkali	1,050,000	993,000
1 per cent alkali	1,066,000	896,000

CHEMICAL DETERMINATIONS.

Ammonia.—The ammonia determinations were made in a manner analogous to that described in Bulletin No. 31 of the United States Bureau of Soils. Ten grams of soil were treated

with 5 grams magnesium oxide (calcined) and 500 grams of ammonia-free water. Of the distillate, the first 150 cubic centimeters were used for nesslerizing. It is true that some of the lower nitrogen compounds such as the amides, are determined as ammonia by this process, but as the object was to obtain comparative rather than absolute data it would seem that this method was sufficiently accurate for the purpose in hand. Ammonia-free water was readily secured from the overflow of an ordinary steam sterilizer into which steam is injected directly.

Nitrates.—The phenoldisulphonic acid method, as described in the above bulletin, was used for all nitrate determinations. Total nitrogen determinations were made in accordance with the method described in Bulletin No. 46, Division of Chemistry, United States Department of Agriculture. All results, bacterial and chemical, were reduced to the dry basis from the moisture determinations.

DESCRIPTION OF MATERIALS USED.

Fertilizers.—The following nitrogenous substances were employed: blood meal, bone meal, bran, and peat. These were selected because of the relative susceptibility of blood meal and bran, and the insusceptibility of bone meal and peat to decomposition. All fertilizers were weighed, dried, and reduced to a finely divided condition by grinding in a mill and passing through a one millimeter sieve. The material was placed in flasks and sterilized one hour at 15 pounds pressure. Subsequent culture tests, made from the sterilized fertilizers proved them to be sterile. The fertilizers were added to the soils at the rate of 0.3 grams of nitrogen per 500 grams of dry soil, or at the rate of 1,800 pounds of nitrogen per acre.

Soils.—Four distinct types of soils were involved, viz, a black marsh soil, sandy in character; a heavy, sticky clay; a light sandy loam; and a pure sand. These soils were secured in the vicinity of Madison, and were passed through a quarter inch sieve to remove all coarse particles. Moisture deter-

minations were made in duplicate, and the amounts equivalent to 1,000 grams of dry soil calculated therefrom.

The soils were placed in one gallon stone crocks, shallow form, which had been previously cleaned and dipped into hot paraffin to prevent the action of soil acids upon the wall of the container. After the fertilizers, in the proportion mentioned above, were thoroughly mixed with the soils, sufficient water was added to bring the moisture content within the limits of 10 to 15 per cent.

DISCUSSION OF RESULTS.

The results of the analyses, as made above, will now be taken up comparatively.

Reference to Tables III and IV, show that ammonifi-

TABLE III.—*Nitrogen as ammonia per gram of dry soil.*

Jar.	Soil.	Fertilizer.	Nitrogen as ammonia per gram of dry soil in parts per million.						
			Jan. 5.	Jan. 19.	Feb. 2.	Feb. 16.	Mar. 2.	Mar. 16.	Mar. 30.
1	Black marsh	Bran	trace	75 5	51.5	25.5	77.6	32.7	144.3
2	Black marsh	Blood meal	,,	49.7	246.6	28.6	37.6	53.7	158.4
3	Black marsh	Bone meal	,,	56.2	108.2	19.2	41.5	39.4	120.4
4	Black marsh	Peat	,,	54.8	91.4	25.1	59.7	67.6	81.5
6	Black marsh	Control	,,	47.8	72.4	50.5	32.1	50.5	69.8
7	Clay	Bran	,,	245.9	111.3	55.1	91.8	59.1	43.9
8	Clay	Bran	,,	73.7	168.5	62.3	21.4	56.6	250.4
9	Clay	Blood meal	,,	125.6	144.8	63.1	38.4	47.4	19.3
10	Clay	Blood meal	,,	92.7	109.9	71.5	151.6	49.2	201.2
11	Clay	Bone meal	,,	103.5	76.8	30.4	35.2	37.4	100.5
12	Clay	Bone meal	,,	225.1	95.8	25.2	30.0	30.2	41.7
13	Clay	Peat	,,	87.0	60 5	25.1	38.4	28.3	62.7
14	Clay	Peat	,,	36.7	69.0	20.2	34.0	26.7	60.1
16	Clay	Control	,,	13.4	23.8	18.0	20.3	4.5	66.1
17	Sandy loam	Bran	,,	548.6	124.0	39.3	40.9	34.1	94.4
18	Sandy loam	Bran	,,	531.9	136.5	42.5	34.4	34.0	131.2
19	Sandy loam	Blood meal	,,	566.8	61.1	33.5	29.9	39.7	78.8
20	Sandy loam	Blood meal	,,	269.2	93.2	28.7	23.9	44.9	73.3
21	Sandy loam	Bone meal	,,	91.1	42.7	23.7	138.2	42.4	63.8
22	Sandy loam	Bone meal	,,	27.1	53.9	21.6	171.5	54.1	107.4
23	Sandy loam	Peat	,,	56.4	25.3	22.5	123.7	38.9	57.3
24	Sandy loam	Peat	,,	56.9	18.7	30.7	85.5	45.8	109.6
26	Sandy loam	Control	,,	48.1	30.5	30.0	109.0	36.1	92.3
27	Sand	Control	,,	28.4	22.3	24.5	90.8	31.3	66.4
29	Sand	Peat	,,	78.3	25.0	8 3	85.5	41.9	83.8
30	Sand	Bone meal	,,	88.0	138.3	16.8	106.7	94.0	173.3
31	Sand	Bran	,,	510.2	532.4	110.3	340.2	100.7	145 0
32	Sand	Blood meal	,,	353.9	415.6	61 7	143.5	121.6	286.2

cation, as measured by the amount of nitrogen occurring in the soils as ammonia, was invariably greatest during the period embraced by the second and fourth weeks after the beginning

of the experiment. After that, there is a marked decline with a corresponding rise in the nitrate content; then follow minor fluctuations until the end of the experiment. Throughout, however, appreciable amounts of ammonia persisted, even in spite of the marked nitrate formation evident in some cases.

TABLE IV.—*Nitrogen as nitrates per gram of dry soil.*

Jar.	Soil.	Fertilizer.	Nitrogen as nitrates per gram of dry soil in parts per million.						
			Jan. 5.	Jan. 19.	Feb. 2.	Feb. 16.	Mar. 2.	Mar. 16.	Mar. 30.
1	Black marsh	Bran	4.3	30.2	103.4	103.4	187.2	388.3	322.3
2	Black marsh	Blood meal	4.7	58.8	250.8	250.8	506.2	296.1	375.1
3	Black marsh	Bone meal	3.2	74.6	96.1	96.1	106.0	172.1	117.0
4	Black marsh	Peat	8.3	22.6	23.4	44.5	43.9	66.4	70.5
6	Black marsh	Control	4.4	12.9	15.7	19.3	23.3	26.9	43.9
7	Clay	Bran	1.8	0.9	20.5	100.8	208.6	157.0	144.1
8	Clay	Bran	2.9	0.6	23.6	94.9	193.3	172.3	173.9
9	Clay	Blood meal	1.7	13.0	129.5	215.3	326.6	234.1	431.9
10	Clay	Blood meal	1.8	13.1	121.8	159.6	202.3	67.1	411.4
11	Clay	Bone meal	1.8	10.7	51.5	117.3	116.5	154.1	129.9
12	Clay	Bone meal	1.9	9.2	82.1	121.9	166.9	46.6	135.4
13	Clay	Peat	1.9	15.9	16.1	40.2	28.0	7.7	18.9
14	Clay	Peat	2.2	15.9	19.3	42.2	27.8	15.8	25.8
16	Clay	Control	1.1	5.2	7.0	16.2	7.9	3.3	6.7
17	Sandy loam	Bran	1.3	2.5	52.5	138.5	131.9	59.1	168.3
18	Sandy loam	Bran	2.2	2.6	44.3	125.3	142.2	49.8	167.2
19	Sandy loam	Blood meal	1.8	7.4	44.5	164.7	188.5	81.2	223.5
20	Sandy loam	Blood meal	2.2	4.0	49.7	162.0	207.2	92.6	237.4
21	Sandy loam	Bone meal	1.8	9.0	100.3	168.1	206.7	113.0	156.7
22	Sandy loam	Bone meal	1.3	17.7	83.6	144.1	123.3	54.1	104.0
23	Sandy loam	Peat	3.9	14.3	9.0	33.8	20.2	7.2	29.2
24	Sandy loam	Peat	3.9	14.3	8.6	20.9	14.6	4.5	12.1
26	Sandy loam	Control	1.9	3.8	4.5	5.6	8.2	2.2	1.7
27	Sand	Control	0.0	0.0	0.0	0.0	0.0	2.4	0.0
29	Sand	Peat	3.1	10.1	7.3	27.2	27.2	13.6	19.2
30	Sand	Bone meal	1.1	3.2	8.7	20.8	88.5	135.5	115.5
31	Sand	Bran	1.3	0.0	0.0	0.0	20.4	31.3	107.9
32	Sand	Blood meal	0.0	0.0	0.0	0.0	0.0	6.8	7.6

That there should have been a development of ammonia before nitrification became active is natural, but that so much accumulated before the activity of the nitrifying organisms began, seems strange. The experiments of Boullanger and Massol,* however, afford a ready explanation of this interesting fact. They have shown that when a marked development of the nitrate formers has occurred, the presence of ammonia has but little effect upon the activities of the mature cells. It must be assumed that the soils used contained living, mature nitrify-

*Lafar Handbuch der Technischen Mykologie, Bd. III. p. 180.

ing organisms, and that, therefore, nitrification occurred in spite of the high ammoniacal content.

There is no steady, constant rise in the amount of nitrogen converted to nitrates, as one might have expected, but instead, numerous fluctuations. To account for the alternating increase and decrease in the nitrate content, is difficult. It is evident that the variations do not come within the limit of analytical error. The very fact that such wide variations occurred in each of the soils tested, independently, would seem to indicate that this occurrence was inherent to the experiment.

Degree of decomposition in the various soils.—In considering this question, numerous factors enter in, which exert a varying influence on the results. In this respect, the fixation of atmospheric nitrogen and the absorption of ammonia from the air are possible factors that must be considered. To determine to what extent these factors were operative, two sets of controls were carried along with the fertilized soils. One consisted of a set of the normal soils to which no fertilizers had been added; the other, a duplicate of the preceding, in which the germ life had been destroyed by addition of formaldehyde. In these control series no appreciable changes in the nitrogen occurred except in the case of the loam. Why it should have been so marked in the loam is a question, unless, possibly, it be due to the absorptive powers of the humus therein contained.

The influence exerted by the different types of soils upon the degree of nitrification is presented in Table V, in which is shown the percentage of nitrogen, added in the form of fertilizers, which was converted to the end product, nitrates. From this it appears that the soils rank in the following order: marsh, clay, loam, and sand.

TABLE V.—*Rank of the soils when based upon the maximum percentage of the added nitrogen which was converted to nitrates.*

Soil.	Fertilizer.	Maximum per cent of nitrogen added converted to nitrates.	Rank.
Black marsh	Blood meal	84.36	1
	Bone meal	28.66	1
	Bran	64.71	1
	Peat	11.75	1
Clay	Blood meal	70.27	2
	Bone meal	23.61	3
	Bran	33 47	2
	Peat	6.86	2
Sandy loam	Blood meal	38.41	3
	Bone meal	27.50	2
	Bran	27.96	3
	Peat	4.56	3
Sand	Blood meal	1.23	4
	Bone meal	22.58	4
	Bran	17.96	4
	Peat	4.53	4

The exceedingly slight nitrification in the sand is probably attributable to the moisture content; owing to the high specific gravity of the sand, 10 per cent of moisture caused an almost water-logged condition. As all water added had been previously sterilized, it contained practically no dissolved oxygen. These two factors would inhibit nitrification, and to some extent promote denitrification. That the latter did actually occur is seen from the total nitrogen determinations at the end of the experiment, which show that a considerable loss of nitrogen had occurred, as is evident in Table VI.

TABLE VI.—*Variation in total nitrogen content of the sand series.*

Fertilizer.	Total nitrogen in parts per million per gram of dry sand at—			Per Cent of loss.
	Beginning.	End.	Loss	
Peat	736	361	375	50.95
Bone meal	747	231	516	69.07
Bran	706	519	187	26.48
Blood meal	765	206	559	73.07

That nitrification should be most marked in the marsh soil is to be attributed, most likely, to the large numbers of nitrate-formers which may be considered as present in this soil, and which were given optimum conditions for their development under the environment in which they were placed during the experiment.

It is seen from the table that clay ranks second. Its high percentage of pore space allows of a more extensive diffusion of the air than occurs in soils with less pore space, such as the sand and the sandy loam. This more thorough aeration greatly promotes nitrification, which is so largely dependent upon the presence of oxygen.

With regard to the changes in the total nitrogen content which occurred in the experiment, an increase was noted in all cases, except in the clay treated with bone meal and blood meal, and in the sand. Whether this increase was due to the absorption of ammonia from the surrounding air rather than to the fixation of atmospheric nitrogen we cannot say. Why clay treated with bone meal and blood meal should lose in total nitrogen, is a question The loss in the total nitrogen of the sand series has been previously ascribed to the reduction processes resulting from the excessive moisture content.

Degree of decomposition of the different fertilizers.—It will be seen from Table VII that, when based upon the degree of decomposition, the fertilizers rank in the following order: blood meal, bran, bone meal, and peat. In other words, for immediate effect, blood meal and bran are preferable to bone meal and peat. The latter two, although less effective immediately, would exert a beneficial influence upon soil for several years.

TABLE VII.—*Rank of the fertilizers when based upon their relative degree of decomposition.*

Fertilizer.	Soil.	Maximum per cent of nitrogen added converted to nitrates.	Rank.
Blood meal	Black marsh	84.36	1
	Clay	70.27	1
	Sandy loam	38.41	1
	Sand	1.23	4
Bone meal	Black marsh	28.66	3
	Clay	23 61	3
	Sandy loam	27.50	3
	Sand	22.58	1
Bran	Black marsh	64.71	2
	Clay	33 47	2
	Sandy loam	27.96	2
	Sand	17.96	2
Peat	Black marsh	11.71	4
	Clay	6.86	4
	Sandy loam	4.56	4
	Sand	4.53	3

GERM CONTENT AND ITS RELATION TO THE PROCESSES OF DECOMPOSITION.

In these studies the bacterial flora was divided into three general groups, each of which could be readily distinguished by their characteristic growths upon gelatin plates. These three classes were liquefiers, non-liquefiers, and streptothrix. The colonies of the latter were surrounded by a deep brown halo, which made them easy to recognize. Molds, which developed in exceptional cases, were ignored.

To attempt anything like a detailed discussion of the mass of data accumulated upon this phase of the experiment is not expedient in this connection. The facts which have been brought out are briefly as follows: It was found that the germ content increased enormously soon after the beginning of the experiment. This applies equally to both the fertilized and unfertilized soils, and must be largely attributed to the thorough aeration which the soils received.

The number of liquefiers which developed was surprisingly low, for it is commonly assumed that the organisms concerned in the decomposition of proteid matter are largely liquefiers, such as Bacillus proteus vulgaris and Bacillus mycoides. These forms, however, do not seem to be involved in the decomposition

of the substances used, for the presence of these organisms was exceptional, and always in small numbers.

In general, the degree of decomposition appears to be directly proportional to the actual numbers of bacteria. Thus the black marsh soil ranks first as to numbers of bacteria, as well as degree of decomposition. Individual exceptions, however, seem to show that it is dependent upon the ratios which the numbers of the various individual groups bear to one another.

Different fertilizers promote the development of different species of bacteria. In this connection it was noted that blood meal, in both sandy loam and sand, practically inhibited the development of streptothrix. Bran promoted the growth of molds; this was particularly marked in the clay soils, where the entire soil was bound together by the development of a mycelial growth. Nitrification, nevertheless, was very marked in spite of this excessive growth of molds. Blood meal in sandy loam prevented all development of liquefiers.

Bran favors the greatest multiplication of the bacteria, whereas peat causes a retardation in their development. All soils treated with bran showed, without exception, the highest germ content.

Non-liquefiers were by far the most predominant type of organisms. In fact, in many cases, none of the other forms were found. It appears from this that non-liquefiers are apparently the forms most closely connected with the process of decomposition.

Ammonification seems to follow closely the variations in germ content, but nitrification lags somewhat behind these.

RESULTS OBTAINED UNDER ANAEROBIC CONDITIONS.

Under anaerobic conditions, denitrification instead of nitrification should occur. This was actually the case, as all the nitrates originally present disappeared by the second week, and thereafter remained absent. As ammonia is the form of nitrogen by which the process of denitrification is measured, the degree of decomposition was here based upon the ammonia developed.

Here, as under aerobic conditions, a considerable fluctuation in the ammonia present occurred. When one considers the maximum amount of original nitrogen converted to the end product, the soils ranked as follows: sand, sandy loam, black marsh, and clay; this is radically different from the results obtained under aerobic conditions, where the black marsh was first, followed by clay, sandy loam, and sand.

Regarding the relative susceptibility to decomposition of the fertilizers here used, bran was found to decompose most readily, whereas under aerobic conditions, blood meal ranked first in this respect.

In germ content, the non-liquefiers constituted the greater mass of the bacteria, liquefiers and streptothrix forms being almost entirely excluded. The numbers of bacteria were larger in the case of the soils treated with bran than those with blood meal. The same was true under aerobic conditions. The fluctuations in the progress of decomposition were much greater and less uniform for the different soils than was the case in the former experiment.

The results obtained by this method were radically different from those secured under aerobic conditions. The method, furthermore, is far more cumbersome, and while nitrification is inhibited in this way, thus making the total amount of the ammonia accumulated greater than would otherwise be the case, the advantages so gained are not sufficient to warrant the much more laborious technique necessary in this type of work.

CONCLUSIONS.

In the foregoing work an attempt was made to study the progress of nitrogenous decomposition in soils from the biochemical point of view.

It is recognized in such a study as this, that the conclusions which may be drawn must be purely tentative. The work cannot be considered as final, and is presented more in the nature of a preliminary reconnaissance of the subject, certain definite phases of which can be taken up from the basis of the data accumulated in this paper.

The facts which are seemingly brought out, are substantially the following:—

The numbers and the character of the bacterial flora in soils are largely influenced, first, by the nature of the fertilizers applied, and second, by the character of the soils themselves.

The number of bacteria in sand is the smallest, amounting to only about one-fifth of that found in the black marsh soil, which contained the greatest number of any of the four soils.

The total number of bacteria which may develop in soils richly fertilized is enormous, aggregating hundreds of millions per gram.

The degree of nitrogenous decomposition is, in a general way, directly dependent upon the total number of bacteria present.

The progress of such decomposition is marked by numerous fluctuations which coincide, in a general way, with an increase or decrease in the number of bacteria.

Extensive ammonification invariably occurs before nitrification becomes active. Large amounts of ammonia may be formed in soil, without interfering with the subsequent development of the nitrate-forming organisms. In soils highly fertilized, as in the foregoing experiment, appreciable amounts of ammonia are invariably present.

As regards the degree of decomposition, the soils tested rank in the following order: black marsh, clay, sandy loam, and sand.

When based upon their relative susceptibility to decomposition, the fertilizers used rank thus: blood meal, bran, bone meal, and peat. In other words, where immediate effects are required, blood meal and bran are preferable; but where the beneficial action of the fertilizers is to be maintained for several years, bone meal and peat are better.

The use of anaerobic conditions has no advantage over the aerobic method, but is, instead, far more difficult to manipulate.

It is to be hoped that the work in hand may suggest new fields for investigation, which may aid in solving the problem of the maintenance of the nitrogen supply of soils.

CRANBERRY INVESTIGATIONS.

A. R. WHITSON, O. G. MALDE, AND C. B. HARDENBERG.

The cranberry season of 1906 has been a successful one for the growers of Wisconsin. The crop, however, was probably not above the normal, in spite of the heavy setting. The blight, fire, and fruit worms caused considerable loss Late May frosts and severe hail storms on June 25 and July 25 also caused a shortage in some localities. The latter part of the season, however, has been exceptionally free from cold nights or frosts, and, as a result, the fruit ripened about a week earlier than that of last year, and was of good color, as compared with the fruit at the beginning of the harvest a year ago.

I. IRRIGATION AND DRAINAGE.

Influence of drainage, sanding, and weeding on soil temperatures.—The study of the influence of local conditions of drainage, sanding, and weeding on soil temperatures, begun two years ago, has been continued this season. Beginning on the first of August, observations of soil temperatures at three inches and six inches below the surface and of air temperatures at two inches, three feet, and forty feet above the surface were made at seven o'clock both morning and evening throughout August and September except that the observations at forty feet above the surface were interrupted on the 21st of August by the wreckage of the observation tower by a severe wind

storm. Soil temperatures at six inches below the surface remained quite constant at about seventy degrees throughout the season. The temperatures at three inches below the surface, and the minimum temperature in the vines two inches above the surface, on five different sections, are given in the following table:—

TABLE I.—*Maximum air temperature for the day; evening and morning temperature three inches below surface; and minimum temperature for the night two inches above surface. All temperatures recorded in degrees Fahrenheit.*

1906. August.	Maximum for the day.	Gaynor Marsh.			Section F. Plot 8.			Section F. Plot 5.			Section G.			Section B.		
		Three inches below surface.		Minimum two inches above surface.	Three inches below surface.		Minimum two inches above surface.	Three inches below surface.		Minimum two inches above surface.	Three inches below surface.		Minimum two inches above surface.	Three inches below surface.		Minimum two inches above surface.
		7 P M.	7 A M		7 P M.	7 A M.		7 P M.	7 A M.		7 P M.	7 A M.		7 P M.	7 A M.	
1	79	.....	63	47.3	.....	66.6	51.8	.....	66	54	.....	65.8	53.8	.....	66.8	54
2	89	66	64.2	53	72.8	68.8	56.2	77.7	69.4	55.2	77.8	68.8	55.4	76.8	69.2	58.7
3	87	66.8	63.9	55.1	74.2	68.2	58.7	88.6	68.4	61	81.4	67.6	61.5	79.8	68	62
4	87	66.5	65.2	48	74.3	69.7	53	81.7	79.5	55.5	83.2	69.9	56.2	81.2	70.3	56.3
5	80	66.7	63.8	65	72	61.8	64.2	75	63.7	65	75.6	63.8	65	77.2	65.2	64.5
6	88	66.1	64.4	46	73	68.2	51.7	73.3	66.3	53	78.8	66.7	53	80	68.1	52
7	81.4	66.2	64.8	59.2	72.8	69	59.5	74.7	68	60.2	76.2	68.7	60.3	76.9	69.7	59.5
8	74	65.2	64.7	56.3	70.3	68.3	60	70.2	67.5	63.5	72.2	68.6	63	71.8	68.8	61.7
9	81	66.1	64.9	63.4	72	69.2	64.4	72	68	65.1	74.9	69	67.5	76	69.8	63.5
10	85.5	67	64	55.4	73.2	68	61	76.2	65.2	62	77.8	65.8	62.8	78	67	61.8
11	82	66	63.8	46	72.4	66.2	52	76.4	63.8	54.2	76.2	62.6	55.2	76.6	64	54.5
12	81	65.4	63	47	71.8	66	48.2	75.6	64.2	49.6	65.6	63.2	48.2	75.8	64.8	50.2
13	85.6	66	63	42.8	72.2	66.8	48.2	76.3	66	51.5	75.7	64.8	51.6	76	66	49.5
14	88	66.2	64	46	74.3	68.7	51.8	80.8	67	53.5	80.9	66	54.5	80.8	67	52.8
15	88	66	64	45.5	72.8	68.8	50.3	75.6	72.6	53	74	71.3	53.2	74	72	51.5
16	90.5	66	64.8	49.5	72	68 8	53.8	72.8	67	56.8	75	67	57.8	73	67.8	55
17	81	66	64.7	54.8	71.5	68.3	57.5	72.8	61.2	60.2	73.5	66.2	60.3	74	67	58
18	87.4	68.8	.....	59	75.5	.....	60	78.8	.....	61.4	79.2	.....	61.5	79	.....	59.5
19	86.3	.....	66	59.6	.....	71.4	62.3	.....	71.8	64	.....	71.5	64	.....	72	61
20	94.5	69.3	67.4	58.8	78.5	73.2	62.8	87.5	74.8	64.5	84	73.8	65.2	72	74	63
21	94	73	67.5	63.5	66	72.6	66	76.5	71.8	67.7	77	72	68	77	72	65.3
22	89	71	69	64.4	74	75	65.5	81	74	67	82	74	67	83	74	64
23	78	67.2	66	64	71	68	66.5	70	65	67.5	70.5	65	67.7	71.5	66	64.5
24	74	67	65.9	59.2	70.2	69.3	59	71	70.1	59.7	71	70.2	59.8	72	71	57
25	87	68.9	67	67.9	73.8	71	67.7	75	69.2	68	76	69.5	68.2	71.4	70	65.2
26	71.3	67	62.8	65.6	70	61.8	65.2	69.4	57.2	67	69	56.2	67.5	71	59.2	64
27	72.8	64.1	61.5	32.8	66.2	61	36.2	65.2	56	38	65.5	55.5	38.9	67.7	57.9	35.8
28	78.8	63.8	62.7	34.6	64.4	63.5	39 5	68.7	71.8	42.2	68	61	42.9	69	62	40
29	74	64	61	44.3	66 4	60.8	48.6	68.9	57.1	37.9	68	55	52	67.8	57.8	50.6
30	74	67.2	60.4	30	63.8	60.2	37.5	69.2	59.1	41.3	67.2	57	41.5	67.8	59.2	40.1
31	75	62.5	60.5	34	65	60	40.2	70.8	59.1	44	72	57.5	45.1	70	58.7	42.8

TABLE I.—Continued.

September. 1906.	Maximum for the day.	Gaynor Marsh. Three inches below surface. 7 P.M.	Gaynor Marsh. Three inches below surface. 7 A.M.	Gaynor Marsh. Minimum two inches above surface.	Section F. Plot 8. Three inches below surface. 7 P.M.	Section F. Plot 8. Three inches below surface. 7 A.M.	Section F. Plot 8. Minimum two inches above surface.	Section F. Plot 5. Three inches below surface. 7 P.M.	Section F. Plot 5. Three inches below surface. 7 A.M.	Section F. Plot 5. Minimum two inches above surface.	Section G. Three inches below surface. 7 P.M.	Section G. Three inches below surface. 7 A.M.	Section G. Minimum two inches above surface.	Section B. Three inches below surface. 7 P.M.	Section B. Three inches below surface. 7 A.M.	Section B. Minimum two inches above surface.
1	76	62.1	62	37.7	63.8	63	43	65	64.1	45.7	65.2	63.9	46.5	65.4	64	42
2	73.7	63.5	61.1	61	66	61.2	61.3	66.8	56.4	61.3	67.2	56.7	61.2	67.8	59.5	57.6
3	77	62.5	60	32.1	65	59.8	39.3	68	55.8	43.2	68.3	55.8	38.5	68.9	57.2	40
4	77	63	60	41	65	60.8	38.9	68.2	56.4	42.2	69.4	56.6	42.8	69	57.7	39.2
5	77	62.2	60	32.4	66	61	38.6	68	58.5	41.3	54	58	42.2	69.2	59.2	37.8
6	81	63	60.7	37	67	62.8	42	72	61.9	44.7	71.5	61	45	71	61.8	40
7	84.3	65.3	61.6	42.1	68.8	64.2	46.7	74	64	49.5	73.1	63	49.8	72.8	63.6	44.2
8	86.7	64.6	62.6	47.1	70.2	65	50.6	76.8	65.3	52.3	76	64	52.4	75.5	64.5	51
9	90.5	65	63.2	47.2	71.8	67.5	50.9	79.9	69.1	53.8	80	68.2	54.5	77.9	67.9	53
10	84.3	65	63.9	53.4	70.8	67.8	57	77.7	69.6	60	77.1	68.7	61	75.1	68.3	61
11	88.7	66	64.6	57.8	72.3	68.2	60	79	69	62	78	68.5	63.2	76	68.7	62.2
12	73.7	64.5	63.4	59.5	67.3	65	61.3	71.2	60.8	62	71.4	60	61.8	74.5	60.8	62
13	65	62.5	59.7	48.8	63.9	59	49.7	63	53.6	58	62.6	52.3	51	62.8	54.1	51
14	65	61	59.5	27.5	61.8	58.9	33	63.3	57.8	36.4	62.8	56.6	36	62.3	57.7	36.2
15	68.8	60.8	62	47	61.7	64	47	64.6	67.7	48.7	64.3	67	49.5	64.4	58	49
16	84.3	64.7	63	58.9	68.5	65.8	58.2	73	65.2	59.4	73	65.5	60	73	65.4	62.1
17	81.1	65.7	64	57.5	70.6	67.3	59.2	74.5	67	61	75	67.3	61.2	74	67.2	61
18	80.4	66	64	57.6	71	66.8	59.3	76.8	64.4	61.7	77.3	64.7	61.8	77.8	64.7	61.3
19	81.2	68.8	62.8	55.8	68	64.4	56.2	69.2	62.6	57.4	69.2	62.6	57.4	69.2	63.6	57
20	74.2	64	63.2	54.1	67.1	65.2	54	69.7	63.8	54.7	70	63.9	54.5	70	64.2	54.3
21	74.8	64.6	61.8	52	67.3	62.8	54.4	67.8	59.7	56.3	68.2	59.7	57	68.2	60.8	59.7
22	62.4	61.3	59.9	41.2	61.7	59	40	63	59.7	49.3	47.7	59.4	49.6	58.7	61.3	49.7
23	62.3	61.2	59	37.4	62	58.1	41.2	62.3	53.1	44.5	62.7	53	44.7	63.8	54.5	45.8
24	70.7	60.8	59	33.8	62.5	68.8	38.2	63.8	54.4	41.7	63.9	54.1	42.4	63.7	55.2	41.8
25	75.4	.....	.....	34.7	.....	.....	39	.....	.....	42.4	.....	.....	44	.....	.....	44.7
26	68	61	.....	40	59.8	.....	44	61	.....	42.5	60	.....	43.7	61	.....	43
27	72	59.3	58.2	26.4	59.8	54.6	29.8	62.5	50.8	33.3	62.7	50.3	33	63.3	52.3	33
28	65.8	58.5	58.8	26.4	58.9	57.8	32	61	57.2	33.3	61	57.1	38	61.8	57.9	36.5
29	64.7	58.9	57.5	51	58.4	52.7	52	60.6	46.8	53.5	59.5	45.2	53.4	59.7	47.2	52
30	63	57	.....	16.8	54.9	.....	25.2	64.3	.....	28.8	62.9	.....	29.8	64.4	.....	29.2
Av.	77.58	61.96	61.75	48.08	68.14	65.1	51.18	70.35	63.75	53.18	69.8	63.07	53.68	70.39	63.74	52.33

These sections are the same as those described in the Twenty-Second Annual Report, page 284, as follows:—

Gaynor Marsh.—Bog, saturated and covered with heavy growing vegetation and dead grass and weeds of previous year's growth.

Section F, Plot 8.—Water kept at surface by pumping; vines clean; ground covered with vines.

Section F, Plot 5.—Water 14 inches below surface; sanded 2 inches, leaving ground about half covered with vines.

Section G.—Sanded 3 inches; water 10 inches below surface; planting one year old and rather thin; ground nearly all exposed.

Section B.—Sand island, leveled off; newly planted ground practically all exposed.

It will be seen from the data in the above tables that the conclusions drawn from last year's observations are corroborated by the studies of this season. Attention should be given especially to the great difference in minimum temperature between plots which are relatively free from weeds and have a surface sanding, and those which are weedy and poorly drained, on nights when the temperature gets low on account of excessive radiation. By comparing the minimum temperatures on the weedy portions of the Gaynor marsh with those of the Experiment Station on those nights when the minimum temperature was 45 degrees, or less, it will be seen that there is a very marked difference between them, and that in a number of instances freezing temperatures occurred on the Gaynor marsh when the temperatures on the other sections remained above the freezing point The importance of keeping cranberry grounds as free as possible from weeds and then pruning the vines themselves is again brought to the attention of the growers as one method of lessening the danger from frosts. Fig. 12 shows Section F, Plot 3, which was pruned in November 1904, and Fig. 13 shows Section F, Plot 6, in need of pruning, and also shows frost on vines photographed on the morning of May 28.

RELATION OF TEMPERATURE IN THE VINES TO THAT THREE FEET ABOVE.

The observations on the differences between temperatures in the vines and three feet above have been continued, using two minimum thermometers, fastened to one stake, the lower one being in the vines approximately two inches above the surface of the ground, and the other 3 feet higher. These temperatures, from May 9 to September 30, are given in the following table:—

TABLE II.—*Minimum temperatures in the vines two inches above the surface of the ground and in the air three feet above the ground.*

Date.—May.	ELEVATION		Date.—June.	ELEVATION		Date.—July.	ELEVATION		Date.—August.	ELEVATION		Date.—September.	ELEVATION	
	Two inches above surface.	Three feet above surface.		Two inches above surface.	Three feet above surface.		Two inches above surface.	Three feet above surface.		Two inches above surface.	Three feet above surface.		Two inches above surface.	Three feet above surface.
.....	......	......	1	33	41	1	52.8	62	1	47.3	53.1	1	37.7	46.1
.....	......	......	2	33.5	44	2	50	52.9	2	53	59.3	2	61	61.9
.....	......	......	3	31	43.6	3	44	51.5	3	55.1	60.4	3	32.1	42.9
.....	......	......	4	47	58.9	4	43.2	53.2	4	48	54.8	4	36.3	34.6
.....	......	......	5	53	61.7	5	40.9	46.8	5	65	64	5	32.4	41.4
.....	......	......	6	54	57.5	6	32.8	44.8	6	46	53.2	6	37	41.3
.....	......	......	7	61.5	61	7	36	47.1	7	59 2	60.1	7	42.1	48.8
.....	......	......	8	45.2	53.5	8	43	53.5	8	56 3	63	8	47.1	52
9	11	23	9	46.5	53.7	9	48	56.3	9	63.4	65.1	9	47.2	52.3
10	15	26	10	50	50	10	53.6	59.4	10	55.4	62	10	53.4	61.9
11	21.3	33.5	11	34.5	38	11	50 4	56.4	11	46	54.3	11	57.8	63.9
12	52	48	12	33.5	41	12	53.4	53.4	12	47	50	12	59 5	61.5
13	48	49.1	13	31	40.3	13	53 9	59	13	42.8	51.3	13	48.8	51.1
14	44.5	44.5	14	38.8	42	14	54	59 5	14	46	52.2	14	27.5	35
15	45.3	53	15	52.8	54.5	15	56	60.3	15	45.5	52.5	15	47	51.2
16	46.5	55.5	16	36.4	44.3	16	37	46	16	49.5	57.5	16	58.9	63
17	55	60.5	17	42.2	51	17	40.5	47.8	17	54.8	60	17	57.3	60.8
18	29	41.8	18	44.4	53	18	38.7	46.2	18	59	61.8	18	57.6	61.7
19	31.7	34.7	19	45	53.7	19	46.3	56.8	19	59.6	64.9	19	55.8	57.2
20	23	32.2	20	54	55	20	50	59.6	20	58.8	65.5	20	54.1	54.2
21	45	45.4	21	40.6	46.2	21	47	55.7	21	63.5	67	21	52	58
22	45	52	22	49.4	49.5	22	51.5	60.5	22	64.4	66.7	22	41.2	48.7
23	40.5	51	23	36	45	23	39	44.8	23	64	67.5	23	37.4	44.2
24	52.3	52.3	24	39	48.9	24	37	45.2	24	59.2	59.7	24	33.8	42.8
25	54.5	53	25	49.7	59.8	25	40	50.8	25	67.9	68.5	25	34.7	45.1
26	41	42	26	51.6	55	26	55.6	58.8	26	65.6	67	26	40	44.3
27	33	33	27	50	57.8	27	43.7	53.5	27	32.8	38.5	27	26.4	33.4
28	38	30.5	28	62	64.1	28	44	51	28	34.6	44.1	28	26.4	37.7
29	47	43	29	62	68.7	29	37	44	29	44.3	53	29	51	53.6
30	43.5	44.2	30	56	58.7	30	40.4	49.8	30	30	41 3	30	16.8	28.2
31	33.5	45	.....	.....	......	31	44	49	31	34	44.1	.....	......	.....
Mo. ave.	36.22	43.31	.....	45.45	51.81	.....	45.23	52.76	.....	52.2	57.3	.....	43.77	49.31
General average for season												.....	44.62	52.05

The average difference for 145 days on which observations were made was 6.67 degrees, and the range of difference was from nothing, on a few days, to 11.4 degrees on September 30, the date on which the lowest temperature of the season was reached. From these data it is again evident that the low temperatures and the formation of frost locally are largely the results of radiation, and that when conditions are favorable for this process, the temperatures in the vines go much below that of the air a short distance above.

Depth of drainage.—The observations on deep and shallow drainage, during the past three seasons on Section F, Plot 6, 7,

Fig. 12.—Section F. Plot 3. Vines pruned in November, 1904.

Fig. 13.—Vines in need of pruning.

and 8, show that the vines on the plots having different depths of drainage have grown about equally well during this time. The yields on the three plots are given in the following table:—

TABLE III.—*Yields for three years on Plots 6, 7, and 8 of Section F.*

Year.	Plot 6, drained 14 inches.	Plot 7, drained 4–8 inches.	Plot 8, water at surface.
	Bu.	Bu.	Bu.
1904	7.56	7.92	7.75
1905	5.3	4.1	3.6
1906	5.6	6.1	5.2
Average	6.153	6.04	5.566

If it had not been for the damage done by frost in May, the yields this season would have been about the same on Plots 6 and 7. There was practically no damage on Plot 8 on account of the presence of water at the surface. The results, therefore, are in favor of thorough drainage, and are probably due to the influence of the warmer average temperatures of drained soil.

Relation of frost formation to humidity.—The observations of 1905 on the relation of the humidity of the atmosphere at 7 p. m. to the minimum temperature of the night, have been repeated during the season of 1906 from May 19 to September 30.

The observations of the dew point on the tower, or at forty feet, ended August 20, owing to the wrecking of the tower, as above mentioned.

The dew point was determined with a sling psychrometer and tables of the United States Weather Bureau, prepared by Professor C. F. Marven.

The readings for 3 feet above surface were taken over bare peat bog, and for 40 feet above surface, on the anemometer tower.

The following table shows the dew point at 3 feet and 40 feet above the surface of the ground, and the fall of the minimum temperature in the vines during the night, below the dew point at 3 feet above the ground at 7 p. m.:

TABLE IV.—*Dew point at 7 P. M. three feet and forty feet above the surface of the marsh. Minimum temperature during the night following and the difference between this minimum and the dew point three feet above the surface.*

Date. 1906.	Dew point. Three feet above surface.	Dew point. Forty feet above surface.	Minimum two inches above surface.	Degrees fall below the dew point.	Date. 1906.	Dew point. Three feet above surface.	Dew point. Forty feet above surface.	Minimum two inches above surface.	Degrees fall below the dew point.	Date. 1906.	Dew point. Three feet above surface.	Dew point. Forty feet above surface.	Minimum two inches above surface.	Degrees fall below the dew point.
May					July					Aug.				
19	39	40	23	16	8	62	63	48	14	24	68	....	67.9	.1
20	40	40	33	7	9	68	66.5	53.6	14.4	25	70	....	65.6	4.4
27	39.5	39.5	38	1.5	10	67.5	68	50.4	17.1	26	52.5	....	32.8	19.7
28	47.5	45	47	.5	12	65	65	53.9	11.1	27	51.5	....	34.6	16.9
30	53	53.5	33.5	19.5	14	64	64	56	8	28	55.5	....	44.3	11.2
31	49.5	49.5	33	16.5	15	53	50.5	37	16	29	52	....	30	22.2
June					16	59	59	40.5	18.5	30	52	....	34	18
1	52	50.5	33.5	18.5	17	61.5	60	38.7	22.8	31	56.5	....	37.7	18.8
3	55	50.5	47	8	18	59	58	46.3	12.7	Sept.				
4	63.5	64.5	53	10.5	19	66	......	50	16	1	60	....	61	0.1
5	61	61	54	7	20	64	......	47	17	2	58.5	....	32.1	26.4
6	70	......	61.5	8.5	21	69	68	51.5	17.5	3	58	....	36.3	21.7
7	58	59	45.2	12.8	23	56	51	37	19	4	54	....	32.4	21.6
8	54	49	46.5	7.5	24	57	......	40	17	5	55	....	37	18
9	55	54	50	5	25	58.5	59.5	55.6	2.9	7	64	....	47.1	16.9
10	50	48	34.5	15.5	26	63	62	43.7	19.3	8	64	....	47.2	17.8
11	49	46	33.5	15.5	27	63	61	44	19	9	68	....	53.4	15.6
12	49	46	31	18	29	62	62	40.4	21.6	10	64.5	....	57.8	6.7
13	47.5	43	38.8	8.7	30	60	......	44	16	11	66	....	59.5	6.5
14	54	54	52.8	1.2	31	58	57.5	47.3	10.7	12	64	....	48 8	15 2
15	57	55	36.4	20.6	Aug.					13	45	....	27.5	17.5
16	65	65	42.2	22.8	1	66	......	53	13	14	46	....	47	0.1
17	58	......	44.4	13.6	2	67	66	55.1	11.9	15	62.5	....	58.9	3.6
18	62	63.5	45	17	3	67	62	48	15	16	71	....	57.3	13.7
19	60	60	54	6	4	69	66	65	4	17	70	....	57.6	12.4
20	54	52	40.6	13.4	5	64	63	46	18	18	70.5	....	55.8	14.7
21	50.5	......	49.4	1.1	6	64	60	59.2	4.8	19	60	....	54.1	5.9
22	54.5	54	36	18.5	7	67.5	67	56.3	11.2	20	65.5	....	52	13.5
23	58	56	39	19	8	67.5	66	63.4	4.1	21	59	....	41.2	17.8
24	63	61	49.7	13.3	9	68	68	55.4	12.6	22	1	....	37.4	13.6
25	62.5	61.5	51.6	10.9	10	69.5	66	46	23.5	23	51.5	....	33.8	17.7
26	60	61.5	50	10	11	60	57	47	13	24	53 5	....	34.7	18.8
27	68.5	65.5	62	6.5	12	60.5	61	42.8	17.7	25	45.5	....	26.4	19.1
28	72	72	62	10	13	62	......	46	16	27	45	....	26.4	18.6
29	62.5	63	56	6.5	14	59.5	70	45.5	14	28	55.5	....	51	4.5
30	62	59	52.8	9.2	15	63 5	64.5	49.5	14	29	39	....	16.8	22.2
July					16	67.5	65.5	54.8	12.7	30	28	....	....	....
1	55	......	50	5	17	68	67.5	56	59.9					
2	58.5	60	44	14.5	19	71	71	58.8	12.2					
3	60.5	60	43.2	17.3	20	75	75	63.5	11.5					
5	54	50	32.8	21.2	21	69.5	......	64.4	5.1					
6	48	49	36	12	22	75	......	64	11					
7	62	......	43	19	23	61	......	59.2	1.8					

It will be seen that the temperature for the night frequently went 20 degrees below the dew point of the evening, and on September 2, went 26.2 degrees below the dew point at 7 p. m. The fall of temperature below the dew point on clear nights is accompained by an excessive dew.

II.—SOILS AND FERTILIZERS.

Sanding.—The sanding of Section F, Plot 5, in March 1905, gave very good results, and, with the vigorous growth of vines obtained this year, should produce a good crop next year.

The yield of this plot last year was 6.6 bushels and this year 7.6 bushels, or at the rate of 132 and 152 bushels per acre.

The sanded plots (1 and 3) on Section E, also produced a vigorous growth of vines this year, and an increase in yield.

The sanding has made an increase in uprights by covering a multitude of runners and allowing them to root and thus invigorate the whole plant.

Fertilizers.—The fertilizer tests have borne out the conclusions of last year. The accompanying table shows comparative yields:—

TABLE V.—*Comparative yields of fertilized plots.*

	Bushels in 1904.	Bushels in 1905.	Bushels in 1906.
Sulphate of potash	5.5	2	3.9
Sodium nitrate	4.8	1.8	3.2
Acid phosphate	4.5	2.3	3
No treatment	4	1.9	2.4
Potash and nitrate	4	4.4	3.9
Potash and phosphate	3.5	4.1	3.6
Nitrate and phosphate	8.5	5.4	5.7
No treatment	6.4	2.7	3.2

III.—CULTURAL METHODS.

Varieties.—In order to make a comparative study of a few of the standard varieties, plots were planted this spring to Bennett's Jumbo, Prolific, Early Ohio, and Early Black. The first three were planted on peat, while the Early Blacks were planted on a sand plot in order to produce as early fruit as possible. All four varieties were cut to lengths of from 5 to 8 inches and planted with the disk and roller, as described in Bulletin No. 119 on pages 28 and 29.

Methods of planting.—To determine whether the removal of moss, and other foreign vegetation, from vines before plant-

ing lessens the growth by injuring the vine or by removing matter which would otherwise act as a mulch, one plot, one by four rods in area, was planted with vines carefully cleaned, and a second plot of the same size was planted with vines not cleaned. The vines were all uncut. The growth this season has been as good on the section on which clean vines were planted as on that on which vines which had not been cleaned were planted, and there being much less foreign vegetation, it will be easier to keep this section clean during the following years.

To determine whether there be any advantage in covering a portion of the vines with muck, as they are planted, over tamping them in in the usual way, one plot was planted in which the vines were first scattered over the ground, and then inverted troughs, eight inches wide, were laid down with their edges four inches apart and soft muck from ditches was then poured on the vines between the troughs from pails, so that strips of ground four inches in width were covered with this muck while the strips eight inches in width between these were left uncovered after the troughs were removed. A second plot w then planted with small vines in the usual method by tamping in. The result was that the vines on the plot where they were covered with muck grew no better than those on the other plot, planted for comparison. On the other hand, the plot where the muck from the ditches was used became very weedy on account of the weed seed from the ditches, so that extra labor was needed to keep it clean. It is probable that if muck from ditches just as they are being made, should be used, that this disadvantage of weediness would not be noticeable, but there does not seem to be sufficient advantage in this method to warrant the extra labor involved in planting.

To determine whether cutting of the vines into lengths of from five to eight inches and planting them by means of the disk and roller, as above mentioned, lessens the vigor of the growth as compared with that made by uncut vines tamped in in the usual way, plots were planted in both ways. So far as could be seen during this season, the growth on the sections

planted with cut vines has been equal to that on sections where the vines were uncut. The fact that a given amount of vines will cover more ground when cut and planted with the disk than where uncut vines are tamped in, would make it profitable to use this method, especially where high priced vines are being planted.

Effect of storing vines.—It is quite customary to pull vines in the fall which are to be planted the following spring, and store them in piles through the winter. Comparisons made last year and recorded in the annual report of 1904, seem to indicate that better results were had when freshly pulled vines were used. Further opportunities have been offered us to study this matter during the present season, since the Jumbo vines, above mentioned, were pulled the day before being planted, while the other varieties had been pulled in October of the previous year and stored through the winter. The Jumbo vines made a more vigorous growth than the other varieties, although these vines appeared to be of equally good stock at the time they were received in the fall.

Method of preparing ground.—The scalping of the land in preparing it for planting not only involves considerable labor, but removes that portion of the soil which is most fertile, so that some have thought it worth while to determine whether the vines would not make better growth planted on land prepared by simply breaking and thoroughly disking. Mr. Barber of Warrens, Wis., seems to have been quite successful the present year in using this method of preparing the land.

Propagation from seed.—Of the two methods of propagation, by cutting and from seed, the former is more commonly used. In fruits which have been cultivated for a long period, the seedlings do not come true to the type of the parent. This variation, however, is less noticeable in wild than in cultivated fruit. To test the cranberry in this respect, the State Cranberry Growers' Association, largely through the efforts of Judge Gaynor of Grand Rapids, had planted the seeds of a number of berries from various vines, which had been propagated on the nursery of the Association. These seedlings are now bear-

ing and the fruit of this year has been compared with the fruit from the respective parent vine. In making this comparison, the fruits of the parent and the seedling have been studied, first, with reference to the uniformity of the parent itself, second, uniformity of the fruit of the seedling considered by itself, third, agreement in color, size, and shape between the fruit of the seedling and that of the parent vine. In order to express the results of this comparison with some definiteness, the degrees of similarity between the berries of the seedling and of the parent vine, in the above mentioned respects, have been marked on the scale of four as perfect, thus making four grades. The results of these comparisons are given in the following table:—

TABLE VI.—*Uniformity of parent and seedling of cranberries with respect to color, size, and shape.*

UNIFORMITY AMONG PARENT BERRIES.				UNIFORMITY AMONG SEEDLING BERRIES.				CONFORMITY OF SEEDLING TO PARENT BERRIES.		
Section No.	Color.	Size.	Shape.	Section No.	Color.	Size.	Shape.	Color.	Size.	Shape.
3	3	3	3	151	2	3	2	2	3	2
22	4	4	4	182½	3	3	2	3	4	2
27	4	3	3	183	4	4	2	3	2	4
31	4	2	3	153	3	3	3	3	2	4
35	4	4	3	185	....	....	....	....	....	....
38	4	4	4	178	4	3	3	3	3	2
39	4	3	3	184¾	4	4	3	4	4	4
43	4	4	3	187	4	2	4	3	3	4
48	4	4	4	159	3	3	2	4	3	3
50	4	4	4	186	4	3	3	3	3	1
51	4	4	4	139	4	4	3	3	4	3
53	4	3	4	154	4	3	3	4	1	4
57	4	4	4	141	4	4	3	3	4	3
59	4	4	4	158	4	3	2	3	3	3
60	4	3	4	184½	4	3	3	4	4	4
61	4	4	4	156	4	4	4	4	4	3
64	4	4	4	134	4	4	4	3	4	4
86	4	4	4	157	4	4	3	4	4	3
87	4	3	3	184	4	4	2	4	3	3
88	4	4	4	138	4	4	2	4	3	3
89	4	3	4	149	4	4	4	3	2	4
99	2	3	4	179¾	3	3	2	2	2	2
Aver'ge	3.86	3.545	3.68	....	3.57	3.43	2.80	3.28	3.28	3.14

The similarity between the berries of seedling and parent vines is frequently striking. This is particularly true in respect to shape. It is evident, therefore, that where there is

any particular object to be gained, it may be possible to use the seed as a method of propagating the cranberry.

Effect of flood on fruit.—On August 7, Plots 3 and 4 of Section F and Plot 1 of Section E, were flooded to kill the fruit worm. Note was taken of the effect of the flood on the fruit, which was about half matured. The water was turned on at 10 p. m., having a temperature of 72 degrees. At 6 a. m. the following day the temperature of the water was 68 degrees and at 3 p. m., 72 degrees.

The water was drawn from Section E–1 at 6 p. m., after having been kept on for about twenty hours.

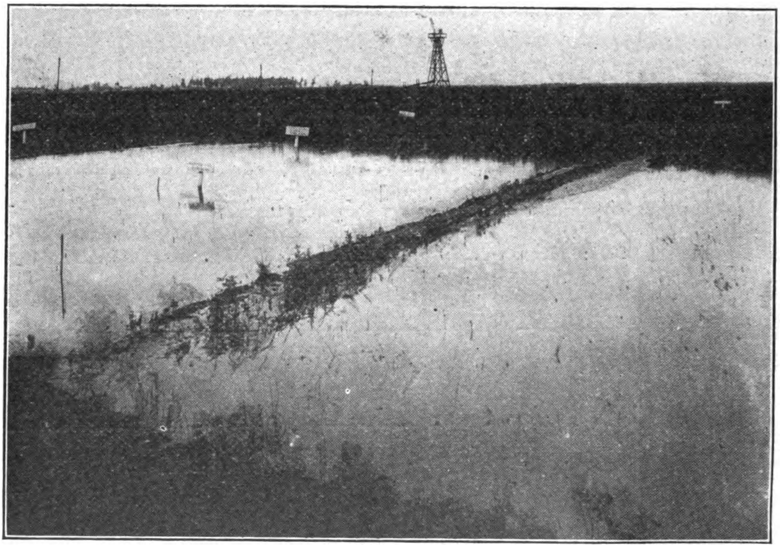

Fig. 14.—A flood on the Experiment Station marsh to prevent frost.

The flood was left on Section F–3 and 4 until 6.30 a. m. on August 9, at which time its temperature was 68 degrees. The water had then been on for a little over 32 hours. Fig. 14 shows this flood of August 8.

The average temperature of the 20-hour flood was 70.3 degrees, and that of the 32-hour was 69.8 degrees.

As a result of the 20-hour flood on E–1 about 5 per cent. of the berries were water soaked, while F–3 and 4 had 50 per cent of the crop water soaked.

We also have the following data, secured by H. R. Laing, in the flooding of one of the Stanley marshes at Berlin on July 15. Water pumped from the Fox River, having an estimated temperature of 60 degrees was used. The flood was on from 5 p. m. July 15, until 4 a. m. July 17, a period of thirty-five hours. When this marsh was visited ten days later, but little damage from water soaking could be noticed, and, with but few exceptions, this was found to have been in berries that had been entered by worms or bitten by other insects.

The evidence is, therefore, that while cranberries will stand a long flooding where the water is of a low temperature, the use of water above 65 degrees must be of a shorter duration.

IV.—INSECT ENEMIES.

The damage inflicted upon the cranberry crop by insects has been increasing from year to year and has become so serious in later years as to command our attention. Although the principal insect enemies of the cranberry have been the subject of investigation in the eastern states by Professor J. B. Smith of New Jersey, and some observations have been made regarding them in Wisconsin during the previous season, it was not until this year that the problem of finding a treatment which would be effective, safe, reliable, and easily applied has been made the subject of special investigation. The services of Mr. C. B. Hardenberg, as entomologist, were secured and he was in the field during July and August.

The chief injury this year has come from the fruit worm and from the black-headed vine worm, with a less amount of damage from the yellow-headed vine worm. A collection of all the small moths found on cranberry marshes has been started to enable the grower to distinguish between the injurious and non-injurious species.

The following moths have been identified on the marshes:—

Pyralis farinalis, Linn., the grainmoth (purely accidental).

Crambus unistriatellus, Packard.

Crambus agitatellus, Clem.

Argyria auratella, Clem.
Plemyria fluviata (Percnoptilota fluviata, Flübner).
Olethreutes bipartitana, Clem.
Olethreutes corruscana, Clem.
Capis curvata, Grote.
Epagoge sulfuriana, Clem.
Hydrocampa genuinalis, Lederer.
Cymatophora inceptaria, Walker.
Chrysophanus epixanthe, Bdv. Leconte.
Eucosma transmissana, Walker.
Archyips rosaceana, Harris.
Euchaetias egle, Drury.
Ammalo teniera, Hbn.
Isia isabella, Abbot & Smith.
Feltia sub-gothica, Haworth.
Heterophleps triguttaria, Herrich-Schaffer.
Heterogenea shutleffi, Packard.
Nymphula icciusalis, Walker.
Schoenobius tripunctellus, Robinson.
Cydia striatana, Clemens.
Erastria amaturaria, Walker.
Crambus ruricolellus, Seller.
Crambus hortuellus, Hbn. (the cranberry girdler).
Archips clementana, Fernold.
Oromophila noctuella, P. & S.
Pseudagossa denticulalis, Harvey.
Crambus innornatellus, Walker.
Peridroma occulta, Linn.

Injury done by various worms.—The greater part of the damage has been done by the fruit worm, the injury having been generally distributed over the entire region. The loss has been estimated by the growers at from 10 to 75 per cent on various areas. The greatest amount of damage was noticed in the region around Mather and Warren, while the marshes around Berlin were found to be practically free from the pest. Around Cranmoor the fruit worm destroyed about 20 per cent of the crop. The black-headed vine-worm (or fire-worm) has

been, locally, a serious enemy, especially around Cranmoor. This is the more dangerous pest, as it works more insidiously, and its work in the first stages is not so easily observed from the dams, so that one has to go down among the vines to look for them. If not noticed in time, however, they spread with remarkable rapidity, and in a few days will destroy acres of vines, the crop being a total loss wherever they have been at work in numbers.

The other pests, yellow-headed vine-worm, cranberry girdler, and katydids, have done no appreciable damage this season.

Fruit-worm.—Moths of the fruit-worm were first seen this year on July 1, but only few were found before the middle of the month, when larger numbers appeared. So far, the egg of the fruit-worm has not been found and the moth itself is seldom seen. It is not found among the large numbers of small moths collected by the use of torches, as explained later, and is probably known to few growers. The berries were first attacked by the worm July 6.

Black-headed vine-worm.—The vine-worm was found to be active on July 17, on the Gaynor marsh near the reservoir dam, where it was quite destructive in patches. The area badly damaged amounted to about five acres. The worm had eaten not only the leaves, but the berry as well, and numerous worms were found within the berries. Its work can readily be distinguished from that of the fruit worm by the irregularity of the hole it makes, which is usually on the side, and by the fact that the hole is never covered with a silken web. The infected portion of the marsh was low and wet, so that apparently this insect, at least in this instance, preferred that to the higher ground.

On July 18 considerable damage by the vine-worm was reported from Babcock. Considerable damage was also done by this worm at Mather.

Other injurious insects.—The species Apegage sulfuriana, Clemens, has not yet been reported as being injurious to cranberries. One, however, was bred from a cocoon found inside a berry on the Gaynor marsh, which at that time was mistaken

for the cocoon of the black-headed vine-worm. The cranberry girdler, Crambus hortuellus, was also frequently found, attracted to torches at night, but the damage done by it has not been much in evidence.

V.—METHODS OF PREVENTING INJURY BY WORMS.

Spraying.—Since both the fruit- and the vine-worm eat their way into the berry, it was thought that it might be possible to kill them by the use of arsenates, such as Paris green. To prevent the development of fungus diseases, Bordeaux was mixed with the Paris green. On July 7 the southeast and northwest corners of Plots F-1 and F-2 and the northern half of nursery Plots 1 to 8 and 16 to 19, inclusive, were sprayed with Bordeaux mixture to which Paris green had been added. The following proportions were used:—

Copper sulphate 6 pounds
Slacked lime 6 pounds
Paris green 1 pound
Water 50 gallons.

The mixture was put on thickly, at the rate of about ten barrels to the acre, the object being to apply as much as the vines would hold. This was done because the surface of the berry is very glossy and the spray mixture does not stick to the surface very well, but runs off and collects in a drop below at the calyx end of the berry. The plants were practically in full bloom at the time of first spraying, and it did not interfere with, but rather favored, the setting of the fruit.

On July 14 the northern two-thirds of the east side of section E-2 was sprayed. The entire section had been sprayed earlier in the season with Bordeaux only, to prevent blight. On July 14, also, a similar area on the marsh of Mr. Warner was sprayed, but a light rainfall that evening washed off most of the mixture. This shows the importance of selecting a clear forenoon for this work. On the 17th an adjoining plot was sprayed with the same mixture.

On July 18 a plot on the marsh of Mr. Ralph Smith was

sprayed with the above described preparation. At this time about 10 per cent of the blossoms were not yet set. The plot selected was one on which the fruit worm had destroyed practically the entire crop the year previous. On another section of Mr. Smith's marsh, which was badly infected with the black-headed fire-worm, a strip was sprayed surrounding the area covered by the worm, with the thought of preventing their spreading, although there were some isolated patches outside of this area. This spraying successfully prevented the spread of the vine-worm, keeping it confined to the area already destroyed. On July 18 it was noticed on the Experiment Station ground, that there was a decided distinction between the sprayed and unsprayed plots, especially on Plots 16 to 19, the unsprayed half being infected by both fruit- and fire-worm, the sprayed half being free from both. Also the southeast and northwest corners of Plot F-1 and F-2, which had been sprayed with Paris green and Bordeaux mixture, were found to be free from both fire and fruit-worms, the surrounding areas being affected.

All the sprayed plots were again sprayed on July 19, and in addition the northern half of nursery, Plots 9 and 15, which had not been previously sprayed, and in which the fruit-worm had already gained a foothold, in order to see whether the treatment applied so late would be effective.

On July 21 it was found that the injury from the fruit-worm was very marked, especially on the unsprayed nursery plots where the worm had been active the year previous. On the 23rd it was found that the sprayed section on the marsh of Mr. Smith had not been attacked, while the surrounding area was badly infected.

On August 4 the northeast corner of Section F-2 was sprayed for the third time. The mixture used contained four pounds of lime, four pounds of copper sulphate, and one pound of Paris green, to fifty gallons of water. The southwest corner of F-2 was sprayed with Paris green and lime only, the copper sulphate being omitted. The northwest and southeast corners of Plot F-1 were left unsprayed to determine whether or not

this third spray was beneficial. No difference was noted in the effect, however, so that apparently this third spraying was unnecessary.

Flooding.—The method of fighting the insect enemies most commonly used in the east is that of flooding the marsh so that the worms are forced to leave the berry and are drowned. The results of experiments with this treatment heretofore tried by the Experiment Station, however, have not been encouraging. The difficulty appears to lie largely in the high temperature of water on the open marshes of this region, which seriously injures the fruit. Some further study of the use of this means has been made during the present season. On July 25 a section of the Gaynor marsh infected with the fire-worm was rolled twice and then flooded for a day. It was found, however, that this treatment was entirely ineffective, so far as killing the worm is concerned.

On the night of August 5, experiments were begun to determine how long submersion is necessary to kill the fruit-worm and how long the berry would stand submersion without injury. The water was turned on at 10:00 p. m., the night being cloudy. The water in the reservoir was 78 degrees; when it reached the plot it was 72 degrees; at 2:00 a m. the temperature was 69 degrees; at 6:00 a. m. it was 68 degrees; the temperature of the water on reaching the vines was 70 degrees at 10:00 p. m., 68 degrees at 2:00 a. m., and 66.5 degrees at 6.00 a. m. By morning the worms had left the berries, but were attached to the hole of entrance by means of a silken thread from the posterior end of the body. Some of the worms were taken from the water and allowed to dry, when it was found that they all revived in five minutes or less. The water was drawn off at 6:45 a. m., after which the fruit worms were found to be on the berries quite generally. Some of these berries were picked and placed on sand in the sunshine, and in about one-half hour the worms had become active and reëntered the holes, and in about forty-five minutes all had disappeared within the berries. Some moved around in the existing holes of other berries, but no new holes were made.

When the plot was examined at 9:30 a. m., all worms were found to have disappeared from the surface and were found to have reëntered the berries. The fruit-worm, when thoroughly wet, sinks in the water, but on account of its being attached to the berry, it floats with the berry and is not drowned nor washed away when the water is withdrawn. The worms were found to be just as active after as before submersion.

An experiment was made to determine how long it takes to force the worm from the berry by submersion, in which it was found that they left the berry in about ten minutes. Some berries with worms attached were removed from the vines at 8:00 a. m., after having been submerged all night, and at 10:30 the worms re-entered the berries. They were put in the water again and at 12:00 m. three were found floating on top horizontally, apparently lifeless, and two found at the bottom. The three found floating were taken out, but revived again in about twenty minutes. At 1:00 p m. those removed from the water were quite active, while the others left in the water were floating. The ones which had revived were again submerged and at 2:00 p. m., seemed again to be lifeless, but revived when removed from the water. These experiments were repeated with water which had been boiled to remove the dissolved air to see if the worm would suffocate, but no difference was noticed. At noon some fruit-worms were brought in from the submerged section. They were still alive after having been submerged for fourteen hours. At 6:00 p. m. wormy berries were taken from the sections which had been submerged for twenty hours, and the worms came to life again in one hour and a half. Lastly, some were taken after having been submerged for thirty-two hours; these were practically all dead; only two out of thirty revived, but did not become very active and succumbed later.

On the Stanley marsh at Berlin, Mr. Laing found the first brood of vine-worms at work about June 17. The second brood was allowed to develop, and on July 15 the marsh was flooded, the water being turned on at 5:00 p. m., the evening being quite cool. Water was put on to the depth of several in-

ches over the vines and the next day being cloudy, it was left on as well as during the following night. The water was drawn off by 4:00 a. m. on July 17 so that the vines were covered less than thirty-six hours. The water used, however, was quite cool, being pumped directly from the Fox River and the temperature was estimated by the man in charge to be below 60 degrees. The result of this treatment was that only a few berries, *i. e.,* those which had been eaten into by the vine-worm, were water soaked, while those which had not been attacked, did not suffer by the treatment. Sound ones were not injured, and it was estimated that less than one per cent was lost by soaking. The activity of the worm was completely checked. No fruit-worm was noticed on that marsh when visited about ten days after this flooding, no vine-worm was found, and no further damage to the fruit was noticed.

From these observations and experiments it appears to be possible to kill at least the vine-worm by flooding when water available for that purpose is of sufficiently low temperature, but that the use of water for this purpose having a temperature of 65 degrees to 70 degrees is impossible without the destruction of the crop.

Use of kerosene.—In order to determine whether some substances which would spread rapidly over the surface of the water and would be injurious to the worm might be found, experiments were begun in the use of kerosene. A preliminary experiment was made with worms which had been submerged for fourteen hours, but were quite active. These were divided into two lots, each being placed with vines in water and one lot covered with a film of kerosene oil and the water siphoned off after an hour. On withdrawing the water, a film of oil was left on the berries and on the worms which had left the fruit. The worms which had been treated with kerosene remained inactive and died, while those from the lot which were submerged for the same length of time, but without kerosene, were allowed to dry and become active, and re-entered the berries.

A second experiment was made by enclosing an area of about four feet square of the marsh with a galvanized iron frame,

flooding this area and applying the kerosene in order to determine whether it would injure the vines in any way. No injury was found to have been done to the vine, except that both vines and berries retained a glossy appearance for a long time.

Another area on nursery Plot No. 50 was enclosed in the same way and filled with water for two hours until the worms were found to have left the berries, when the surface was covered with kerosene and the water allowed to seep out gradually. All the worms were killed and no injury was noticed to the vines, either at once or later. The kerosene in this case was applied liberally, about one-half gallon being poured on the area of sixteen square feet.

On August 13, Section E-4 was again flooded for one night and kerosene applied at the place where the water was let in so as to assist in the spreading of the film. The amount of kerosene was about five gallons to one-tenth of an acre. In the morning a great deal of the kerosene had evaporated and, the film no longer being continuous, another gallon was sprinkled on before the water was withdrawn. The worms on this plot were killed, but it was noticed that the berries, especially at the place where the extra kerosene was applied, colored much more quickly than the others.

Effect of kerosene on the berry.—At those places where the kerosene had been applied liberally, as in the galvanized iron square, the kerosene smell was noticeable for a long while, and the oil had apparently entered the berry itself, for this had a slight kerosene taste, even after the smell had disappeared. On the Plot E-4, where the kerosene was applied at the rate of one barrel to the acre, this effect was not noticed. On the acre where some additional oil was applied before the water was drawn off, it was found that the berries colored up much earlier than those of the surrounding area. Whether or not the treatment affects the keeping qualities of the fruit it is not possible to state at present. We intend to continue experiments along this line the next season in order to get more definite data as to the quantity which can be safely used. At present the method is not recommended for general use.

Torches.—Many growers believe that the burning of torches at night is of great advantage, thousands of millers being caught in this way. In order to ascertain whether or not the ravages of insects might be prevented by using light to attract them, torches were kept burning every night on the experimental grounds when the weather conditions permitted. These torches attracted a large number of moths, the greater part of which were varieties given in the list on pages 149-150, but very few of the injurious millers were caught by this means. Not a single fruit-worm miller was found among them. A few yellow-headed vine-worms, and, later in the season, black-headed vine-worms were entrapped; but apparently this method does not promise to be effective. These moths are found flying around mostly in the evening twilight, and are not seen during the night.

It is possible that a different placing of the torch, that is, lower among the vines, instead of on the dams, and the use of larger numbers, may prove beneficial. Some growers consider the use of the torch advantageous. Though uncertain of the right moth being caught in the pans, they claim to have noticed a decreased amount of damage done by the pests in the immediate neighborhood of the torches, as compared with the adjoining areas.

Summary of results.—1. Spraying with arsenates has been found an effective means of keeping the insects in check, both as a preventative and as a remedy. The greatest benefit results from early spraying. The first application should not be later than July 1, to be followed by one or two other sprayings at intervals of 10 to 14 days.

2. Flooding as a remedy for fruit-worm is not to be relied upon under the temperature conditions prevailing on the open marshes of Wisconsin during the period when it would be most effective. If water of a sufficiently low temperature can be obtained through pumping from a flowing stream, or from a lake, there is no remedy that is more effective and more easily applied than a submersion of the vines. This submersion should continue at least thirty-six hours (two nights and a day).

3. A short flooding, sufficient to bring the worm out of its retreat, followed by the application of a contact poison, as soon as the water is drawn off, should be a treatment well suited to our conditions. The experiments with kerosene in this connection have not yet yielded to any definite data, as the oil has been too liberally applied (for the purpose of noticing whether the vine would be injured by it). We intend to carry on experiments along this line the next season.

4. The use of torches cannot be relied upon as a satisfactory preventative.

5. Clean culture is desirable since the weeds on the marshes will seriously interfere with the treatment for the insect pests, except in the case of continued flooding. We cannot place too much emphasis on keeping the dams free from vines. In almost every case we have found that the insect pests had started from the high dams and usually we found the vines on the dams the most affected. The vines which are not submerged by the winter flood are favorite hibernating places and also offer opportunities for egg laying, while the vines on the marsh are still submerged. A good illustration of the importance of this was noticed on one of the marshes in the Mather region, where the fruit-worm was doing considerable damage on all the marshes except one, which was entirely free from this pest. On this marsh the dams were kept scrupulously clean from vines.

6. Both fruit-worms and black-headed vine-worms were found to be attacked by a special parasite, which was bred from them, the species of which have not yet been determined. The percentage of the affected individuals is, however, so slight that the presence of the parasite cannot be relied upon to keep them in check.

THE NITROGEN CONTENT OF SOILS AS AFFECTED BY METHODS OF FARMING.

A. R. WHITSON, C. W. STODDART, AND A. F. McLEOD.

The importance of nitrogen as an element of plant nutrition is very generally recognized. Because this element is not derived from the rocks, but must be gathered from the atmosphere, and on account of the various ways in which it may be lost, it must receive more attention than most other elements which are taken by plants from the soil. Nitrogen occurs in variable quantities in virgin soils; in some cases there is a sufficient supply for a large number of crops, while in others relatively few crops will exhaust the natural supply. It is well understood that certain organisms which attach themselves to the roots of leguminous plants and form nodules are capable of taking the gaseous nitrogen from the soil air and combining it with other elements into compounds which become available to the plants to which these organisms are attached. It has more recently been shown that there are also organisms which do not attach themselves to the roots of any plants but are, nevertheless, capable of fixing nitrogen in the substances of their bodies, which, by subsequent decomposition, become available to higher plants. The extent of this fixation, however, is not well known. Moreover, changes are constantly taking place in the composition of nitrogenous material in the soil so that compounds are formed which are available to crops but which may be lost by percolation if not used. Furthermore, there are changes by which nitrogen is set free as a gas,

and thus lost to crops. Most of these changes have been studied to a considerable extent in the laboratory, but their occurrence in natural field conditions is only partially understood. We are, therefore, in great doubt as to the extent to which these losses, due to various causes, extend under natural field conditions.

Some studies have been made, especially in Minnesota and North Dakota by Professors Snyder and Ladd, which indicate that the nitrogen lost from the soil by leaching and denitrification is much larger in amount than that taken by the crops themselves. On account of the importance of this matter, a full study of the changes in the nitrogen content of field soil under various systems of farming has been undertaken. The work so far has involved a collection of samples of soil from a large number of fields, the histories of which are fairly well known, and of samples of the virgin soil surrounding and adjacent to them. Assuming that the virgin soil is now in the condition in which the field was at the time of first breaking and beginning of cultivation, it is possible to determine the loss of nitrogen from the field soil by subtracting the amount now found in the field soil from that found in the virgin soil surrounding it.

The collection of these pairs of samples has been done with extreme care. Each sample consists of from ten to twenty cores of soil 1 inch in diameter and 8 inches in depth, taken by means of the King soil tube. In every instance care has been taken that the samples represent soil originally as nearly in the same conditions with reference to slope, character of vegetation, thickness of soil, etc., as possible. The ten to twenty cores of each sample were then mixed, and all, or such part as was necessary, air dried and worked up in the mortar until it would pass through a 20 mesh sieve. The exact yields of the crops grown on these fields and the exact number of crops of each kind are, of course, not known in most cases. Such fields have been selected as have either been under the management of the present owner for a long period of years, or the histories of which are quite definitely known by the

present owner. Estimates have been made as to the amount of nitrogen removed by crops and the amount added in manure or by clover. When such changes are compared with the difference now found between the cropped and virgin soil, it is possible to estimate the loss in other ways than through crops. It is fully recognized that this method is of an approximate nature only, and that in a single instance the determination would have relatively small value. By making this study on a large number of fields, however, it is believed that a very much more reliable conclusion will be reached than by refined work on any single field or on material under laboratory conditions. Only a part of the samples which have been collected have been analyzed up to the present time.

1. (219–220) Samples from the farm of Mr. A. C. Koll, seven miles northwest of Eau Claire. This field had been cropped 27 years, including wheat 10 years, which averaged about 20 bushels to the acre, barley and oats six years, average crop, and corn 4 years, average 40 bushels per acre. The remainder of the time it has been in hay and pasture, including about three crops of clover, and has been manured twice with about 15 tons of manure per acre each time. It is estimated that the crops removed took about 840 pounds of nitrogen per acre, and that the manure and clover added about 420 pounds per acre. The virgin soil at present shows .101 per cent of nitrogen, and the cropped field shows .068 per cent, so that there is at present a difference of 660 pounds per acre, leaving an apparent loss, above that taken by crops, of 240 pounds of nitrogen per acre.

2. (225--226--227--228) This field is on the farm of Mr. Lindeman, near Hudson. It is a clay loam for the most part, though the south end of the field is somewhat sandy. It has been cropped 40 years, chiefly to small grain, the yields of which were good at first but are now only about equal to 14 bushels of rye per acre. The average yield indicates that there has been a total loss of 720 pounds of nitrogen per acre. Two pairs of samples were taken, one from the north and one from the south end, which showed an average difference of

930 pounds of nitrogen per acre between the virgin and cropped soil. There is, therefore, an apparent loss of about 210 pounds of nitrogen per acre in addition to that taken by the crops.

3. (231–232) The field is on the farm of Mr. B. A. Imholt, two miles east of Stillwater, Minn. The field has produced twenty crops of small grain with very little fertilizer. This is estimated to have removed about 600 pounds of nitrogen per acre. The virgin soil now shows .124 per cent of nitrogen; the cropped soil, .080 per cent indicating a loss of 880 pounds per acre, or 280 pounds in excess of that removed by the crops.

4 (232–234) This field is on the farm of Mr. J. M. Thelen, near Houlton, Wis. The field has been cropped to small grain, wheat, oats, and rye, and the straw burned for 45 years. It is estimated that this has removed about 1,125 pounds of nitrogen per acre. The virgin soil now contains .163 per cent of nitrogen and the cropped soil, .101 per cent, indicating a loss of 1,240 pounds of nitrogen per acre, or about 115 pounds in excess of that removed by crops.

5. (236–238) This field is on the farm of Mr. E. V. Porter, Viroqua, Wis. It has been cropped about 20 years, chiefly to oats, corn, and timothy. It has grown three crops of tobacco and has been manured five times. It is estimated that the crops have removed about 1,040 pounds of nitrogen per acre, and that the manure has added about 500 pounds, leaving a loss by crops over that added in manure of 540 pounds. The virgin soil now shows .246 per cent nitrogen and the cropped, .169 per cent, indicating a total difference of 1,540 pounds of nitrogen per acre, or 1,000 pounds more than that removed by the crops.

6. (239–240) This is from the farm of Mr. M. T. Bentson, Viroqua, Wis. This field has been cropped 50 years to corn, oats, timothy, and some clover. It has had two dressings of manure. The estimated loss of nitrogen by the crops is 1,550 pounds per acre, and that added by clover and manure about 700 pounds, making the amount removed by the crops 850 pounds more than that added. The virgin soil now contains .280 per cent of nitrogen and the cropped soil, .242 per cent,

or a difference of 780 pounds per acre, which is 70 pounds less than the amount estimated to have been removed by the crops in addition to that added by manure and clover.

7. (244–245) This is from the farm of Mr. T. Stoleson, near Viroqua, Wis. It has been cropped 60 years to small grain and has neither grown clover nor been fertilized. The yields have been steadily decreasing and are now very light. The field is on a moderate slope and shows some evidence of washing. It is estimated that the sixty crops have removed 1,800 pounds of nitrogen per acre. The virgin soil now shows .327 per cent of nitrogen and the cropped .172 per cent, indicating a loss of 3,100 pounds per acre, or 1,300 pounds in excess of that removed by crops. A considerable part of this has probably been due to side hill wash.

8. (246–247) This field is on the farm of Mr. John Schilling, Onalaska, Wis. The soil is a sandy clay and the field has been cropped about 40 years to corn and oats, with practically no clover or other fertilizer. It is estimated that the crops have removed about 1,200 pounds of nitrogen per acre. The virgin soil now contains .154 per cent of nitrogen and the cropped soil .074 per cent, or 3,080 and 1,480 pounds respectively, indicating a total loss of 1,600 pounds of nitrogen per acre, or 400 pounds in excess of that removed by crops.

9. (252–253) This field is on the farm of Mr. John Williams at Lancaster, Wis., and was cropped 50 years, principally to corn, until the fertility was greatly reduced. During the past twelve years a rotation has been practiced. It is estimated that the crops have removed 1,700 pounds of nitrogen per acre. No clover has been grown nor manure applied, and the land has been pastured the past four years. The virgin soil now contains .201 per cent and the cropped soil, .131 per cent of nitrogen, or a difference amounting to 1,400 pounds per acre, 300 pounds less than is estimated to have been removed by crops, indicating that there has been a gain from some other source of approximately 300 pounds.

10. (254–255) This field is on the farm of Mr. Tom Carmody of Lancaster, Wis. It has been cropped 40 years to corn

and grain. It is a clay loam soil, and has been manured five times and still gives good crops. It is estimated that the crops have removed about 1,600 pounds of nitrogen and that 500 pounds have been added in manure. The virgin soil now shows .136 per cent and the cropped soil, .087 per cent of nitrogen, indicating a total difference of 980 pounds per acre, which, together with the 500 pounds added in manure, equals 1,480 pounds, or 120 pounds less than that estimated to have been removed by crops, which amount has apparently been added from some outside source.

11. (256–257) This field is at Lancaster, Wis. It has been cropped 50 years, at first chiefly to corn and later to small grain. During the last few years a systematic rotation of corn, grain, and hay has been practiced. It is estimated that the crops have removed about 1,500 pounds of nitrogen. The virgin soil now shows .126 per cent and the cropped soil .079 per cent, indicating a present difference of 940 pounds of nitrogen per acre, or 600 pounds less than that removed by crops. A part of this may have been added while the land was in pasture but the present difference does not seem to be as great as would be caused by the crops which have been removed, indicating a possible gain from outside sources.

12. (242–243) This field is on the farm of Mr. G. E. Olson, Westby, Wis. The soil is a clay. The field has been cropped about 60 years and up to 20 years ago produced grain when there was little attempt at rotation or careful cultivation. During the last 20 years, however, it has been more carefully farmed and has been cropped to a rotation of oats, clover, and timothy, with no corn. It is estimated that the crops have removed 1,800 pounds of nitrogen per acre and that the clover may have added 600 pounds. The virgin soil shows .107 per cent and the cropped soil, .088 per cent of nitrogen, or a difference of about 300 pounds of nitrogen per acre, which is over 800 pounds less than would be expected from the crops that have been removed and clover grown, as described above. There seems to have been a considerable gain of nitrogen in this instance by fixation.

13. (261–262) This field is on the farm of Mr. Gust. Laabs, Lancaster, Wis., and has been under cultivation 40 years. Until recently it was poorly farmed, but the last few years, under the present owner, it has been carefully managed. It is estimated that the crops have removed in the neighborhood of 1,400 pounds of nitrogen per acre, while the virgin soil now shows .212 per cent of nitrogen and the cropped, .091 per cent, indicating a present difference of 2,420 pounds of nitrogen per acre, or a loss of 1,000 pounds per acre more than that removed by crops.

14. (264–265) This field is on the farm of Dr. Ruggles at Ridgeway, Wis., and has been under cultivation 70 years. During the first 30 years the farm carried a considerable amount of stock, after which, for nearly an equal length of time, it was cropped principally to small grain and not much stock was kept. During the last few years it has been under better management. The records of crops and treatment are not sufficiently accurate to permit of an estimate of the amount of nitrogen removed by crops, but at the present the virgin soil surrounding the field shows .178 per cent and that of the field itself, .112 per cent of nitrogen, amounting to a difference of 1,320 pounds of nitrogen per acre.

15. (266–267) This field is on the farm of Mr. D. M. Davis, five miles north of Barneveld, Wis., and has been cropped 50 years. During the first thirty years it was in small grain entirely, chiefly oats with practically no fertilizer. This is estimated to have removed at least 1,500 pounds of nitrogen per acre. The virgin soil now shows .159 per cent of nitrogen and the cropped soil .070 per cent of nitrogen per acre, indicating a present difference of approximately 1,800 pounds of nitrogen per acre, or 300 pounds more than is estimated to have been removed by crops.

16. (268–269) This field is on the farm of Mr. D. J. Davis, four miles north of Barneveld, Wis., and has been cropped more than 50 years. In recent years it has been rotated to corn, oats, some other grains, with timothy, clover, and pasture. It has been manured a few times. While the records of this

field are not definite, it is probable that at least 1,600 pounds of nitrogen per acre have been removed in crops and not more than 700 pounds per acre have been added in clover and manure, leaving at least 900 pounds which must have been taken from the soil. The virgin soil shows .158 per cent and the cropped soil, .091 per cent of nitrogen or a present difference of 1,340 pounds per acre, which is approximately 440 pounds more than would seem to have been removed by crops in addition to that added in manure and clover.

17. (273–274) This field is on the farm of Mr. Oscar De Haven, two miles west of Monroe. The soil is a clay, underlaid with limestone with some flint at the surface, and has been cropped 35 years to wheat, corn, oats, rye, and hay, chiefly clover. It is estimated that these crops have removed about 1,200 pounds of nitrogen per acre and that the clover and manure, which was applied six times, have added about 1,200 pounds per acre. The virgin soil contains .139 per cent and the cropped soil, .098 per cent of nitrogen, indicating a present difference of 800 pounds per acre, which is also the amount of loss over that removed by crops and added in clover and manure.

18 (275–276) This field is on the farm of Mr. A. L. Andrews, South Wayne, Wis., and has been cropped nearly 60 years, chiefly to wheat until 1865. Since then some attempt has been made at rotation. The field has produced 15 crops of oats, 10 of corn, 12 of wheat, 2 of rye, 8 of hay, chiefly clover, and has been pastured three years. It is estimated that the crops have removed about 1,600 pounds of nitrogen per acre, and that about 600 pounds have been added by clover and manure. The virgin soil shows .203 per cent and the cropped soil, .115 per cent of nitrogen, indicating a loss of 1,760 pounds of nitrogen per acre, or about 760 pounds more than was removed by crops after the addition by clover and manure was subtracted.

19. (482–483) This field is on the farm of Mr. Alexander Krueger, three miles northeast of Watertown, Wis., and has been cropped 56 years; during half of this time it has been in wheat and during the remaining time in barley, corn, oats, and hay. The field has been manured five times at the rate of

18 loads per acre. A four year rotation has been practiced during the past 16 years. It is estimated that the crops have removed about 2,100 pounds of nitrogen, and that about 900 pounds have been added in clover and manure, so that the crops have removed 1,200 pounds more than has been added. The virgin soil shows .222 per cent of nitrogen and the cropped, .119 per cent, indicating a difference of 2,060 pounds of nitrogen per acre, or 860 pounds more than can be accounted for by the crops removed.

20. (560–561) This field is on the Jewett Mills Farm, Jewett Mills, Wis. The field has been cropped about 30 years, chiefly to small grain and timothy, with no clover or other fertilizer. It is estimated that at least 900 pounds of nitrogen per acre have been removed in these crops. The virgin soil shows .147 per cent and the cropped soil, .123 per cent of nitrogen, indicating a present difference of approximately 500 pounds of nitrogen per acre, or 400 pounds less than have probably been removed in crops, which amount would seem to have been gained from some outside source.

21. (542--543--544--545) This field is on the farm of Mr. G. C. Larson, Cambridge, Wis., and has been cropped to tobacco 30 years in succession. The soil is a sandy loam, and crops have been excellent. About 15 loads of manure per acre have been applied each year, which is estimated to have added 150 pounds of nitrogen per acre. The tobacco is estimated to have removed 75 pounds of nitrogen per acre. Two pairs of samples have been taken from this field, the average of the virgin soil being .131 per cent and of the cropped soil, .089 per cent, which indicates a loss of about 840 pounds of nitrogen per acre in addition to that added in the manure.

For comparison, the results given above are brought together in a table.

TABLE I.—*Nitrogen content of cropped and virgin soil, the changes caused by cropping, addition in manure and clover, and loss by denitrification and leaching.*

No.	Laboratory numbers of samples.	Per cent of nitrogen in cropped soil.	Per cent of nitrogen in virgin soil.	POUNDS PER ACRE.					
				Excess of nitrogen in virgin over cropped soil.	Taken by crops.	Added in manure and clover.	Removed by crops more than added by manure and clover.	Loss by leaching and denitrification.	Gain possibly due to fixation.
1	219-20	.068	.101	660	840	420	420	240	....
2	225-6-7-8	.084	.130	930	720	0	720	210	....
3	231-2	.080	.124	880	600	0	600	280	....
4	233-4	.101	.163	1,240	1,125	0	1,125	115	....
5	236-8	.169	.246	1,540	1,040	500	540	1,000	....
6	239-40	.242	.281	780	1,550	700	850	....	70
7	244-5	.172	.327	3,100	1,800	0	1,800	1,300	....
8	246-7	.074	.154	1,600	1,200	0	1,200	400	....
9	252-3	.131	.201	1,400	1,700	0	1,700	....	300
10	254-5	.087	.136	980	1,600	500	1,100	....	120
11	256-7	.079	.126	940	1,500	0	1,500	....	560
12	242-3	.088	.107	300	1,800	600	1,200	....	900
13	261-2	.091	.212	2,420	1,400	0	1,400	1,000	....
14	264-5	.112	.178	1,320	....	....	....	....	....
15	266-7	.070	.159	1,800	1,500	0	1,500	300	....
16	268-9	.091	.158	1,340	1,600	700	900	440	....
17	273-4	.098	.139	800	1,200	1,200	0	800	....
18	275-6	.115	.203	1,760	1,600	600	1,000	760	....
19	482-3	.119	.222	2,060	2,100	900	1,200	860	....
20	560-1	.123	.147	500	900	0	900	....	400
21	542-3-4-5	.089	.131	840	2,250	4,500	....	3,090	....
	Average .	.1068	.1698	....	....	....	....	....	....

It will be seen from this table that in six out of twenty-one cases, the difference in amount of nitrogen in the virgin and cropped soil is not enough to account for the crops which have been removed. It has been established recently that there are other classes of bacteria than those which form tubercles on leguminous plants, which have the power of fixing nitrogen from the soil air, and it is probable that the addition in these cases is due to this cause.

On the average, the determinations show that the loss by leaching and denitrification amounts to only 22.3 per cent of the amount of nitrogen removed by crops. The evidence seems to indicate that in clay loam soils of moderate fertility, more than four-fifths of the nitrogen lost is removed by crops.

It is probably true that in soils of a higher degree of fertility, and especially where large amounts of fertilizers are

used on land growing late cultivated crops, there is a larger loss of nitrogen by leaching and denitrification than is noted in the above cases. Nevertheless, the entire loss of nitrogen from these fields is, on the average, 37.1 per cent of their original content, as determined by this method. This indicates clearly the limited store of nitrogen in such soils and the importance of maintaining it by the growth of clover, or other legumes, and manure.

We desire to express our appreciation of the aid rendered by Mr. Martin Nelson in collecting and analyzing a part of the samples described.

AVAILABILITY OF PHOSPHATES IN RELATION TO SOIL ACIDITY.

A. R. WHITSON AND C. W. STODDART.

I. SOIL ACIDITY AS AN INDICATION OF LACK OF AVAILABLE PHOSPHATES.

Experience has shown that a direct determination of the amount of the essential elements present in a soil does not show its fertility, since it does not consider the degree of availability. It is unquestionably true, however, that the processes by which these elements become available are chemical and depend on the conditions existing in the soil. An effort ought, therefore, to be made to determine the conditions in the soil which influence the rate at which the elements become available, and which affect the accumulation of the available material. A knowledge of these conditions would enable us to diagnose the needs of a soil more quickly and surely than by direct field and plot experiments.

Investigations during the past two or three years show that acid soils need phosphates. A brief study of fertilizer tests at other stations discloses the fact that, although not commented upon, acidity and need of phosphates are found together. H. J. Wheeler (United States Department of Agriculture, Farmers' Bulletin No. 77, "The Liming of Soils"), says that phosphate rock is effective on acid soils, particular attention having been devoted to its use on acid muck or peat soils; and again, (Rhode Island Experiment Station Bulletin No. 68, "Treatment of Sandy Soils of Rhode Island") he concludes from fer-

tilizer tests on very acid soils, that they are extremely deficient in phosphates. C. E. Thorne (Ohio Experiment Station Bulletin No. 159, "Maintenance of Fertility") states that clover on a certain acid soil is benefited not only by lime but by both phosphates and potash; and in a later bulletin (No. 167), Snyder and Cook conclude from plot tests, as well as wire basket and soil extract tests on acid soils that acid phosphate produces a marked response.

This subject seems worthy of further consideration, for if a general statement can be made that phosphate fertilizers should be applied to acid soils, it becomes a simple matter to detect the lack of available phosphates by testing the soil for acidity with litmus paper. In this connection, therefore, numerous soils have been tested for fertilizer requirements both in the field and plant house.

The following is a list of the soils tested, with a statement as to acidity and need of phosphates:

No. 74, from Janesville. Cropped for many years; badly run down; clover failed and corn poor; slightly manured once. This soil is acid and judging from a plant house test, needs phosphates.

No. 84, from Viroqua. Cultivated about forty years; during the last twelve years rotated to grass, corn, and oats; clover failed; some pasture; acid. Plant house and field tests show that it needs phosphates.

No. 62, a peat from Marinette. Uncropped; marsh drained and tests made on the virgin peat; acid. Plant house and field tests show that it needs phosphates.

No. 239, from Viroqua. Cropped fifty years to corn, oats, clover and timothy in irregular rotation; is in good state of fertility; no manure used for fifteen years; acid. Field tests with oats and clover show that it needs phosphates.

No. 244, from Viroqua. Cropped sixty years, oats continuously for past ten years; clover unsuccessful; is in low state of fertility; acid. Field tests with oats show the need of phosphates.

No. 246, from Onalaska. Cropped about forty years to corn

and oats; little or no clover; badly exhausted; acid. Field tests with oats and corn show need of phosphates.

No. 277, from South Wayne. Cropped sixty years, first to wheat, then mixed farm crops with some stock kept on the place; crops all removed; is badly depleted; acid. Field test with oats shows need of phosphates.

No. 293, from Twin Bluffs. Cropped forty years; some wheat, corn, and oats; crops sold off; the soil has been kept up for twenty years; acid. Field test with oats shows need of phosphates.

No. 297, from Black Earth. Cropped twenty years in rotation and fairly well managed; is in fair state of fertility; acid. Field tests with oats and clover show need of phosphates.

No. 551, from Viroqua. Cropped forty years with no definite rotation; is in low state of fertility; acid. Plant house test shows need of phosphates.

No. 552, from Lancaster. Cropped fifteen years with no change; has been under cultivation for forty years; acid. Plant house test shows need of phosphates.

No. 554, from Sussex. Cropped fifty-nine years to wheat, barley, oats, clover, and corn; manured seven times; is well cared for, yet fertility is falling off; acid. Plant house tests show need of phosphates.

No. 556, from Sun Prairie. Cropped from forty to fifty years; continuously to oats for the past ten years, except hay one or two years; is in low state of fertility; acid. Plant house test shows need of phosphates.

No. 111, from Stanley. Cropped three years; very poor yields; differing from rest of this region; not acid. Plant house test shows need of phosphates.

No. 553, from Watertown. Cropped fifty-five years to wheat, barley, oats, corn, and clover; six dressings of manure; is in low state of fertility; not acid. Plant house test shows very slight, if any, need of phosphates.

No. 555, from Sussex. Cropped about sixty years to barley, corn, and oats; no clover; not acid. Plant house tests show need of phosphates in addition to potash.

No. 102, from Stanley. Field adjoining No. 111; cropped about six years; good yields; not acid. Plant house test does not show the need of phosphates,

No. 124, from Plot 9, Station farm at Madison. Cropped almost continuously to corn for the last thirteen years, with no fertilizers; not acid. Plant house and field tests do not show the need of phosphates.

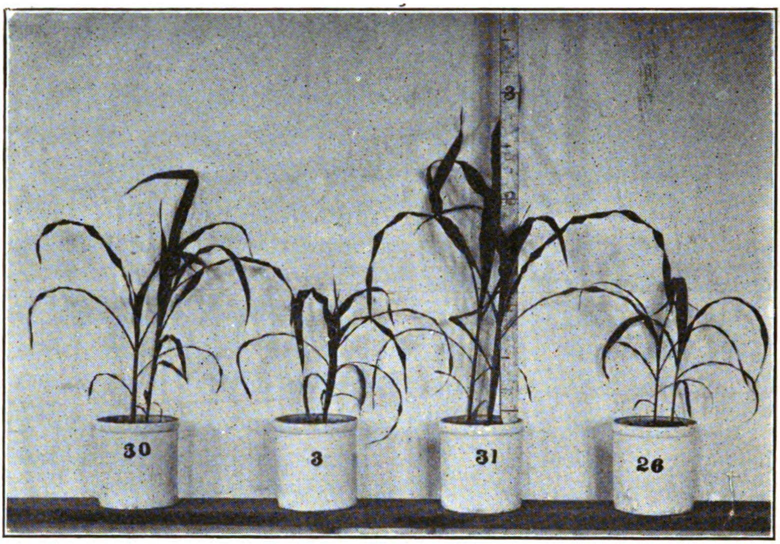

Fig. 15.—Fertilizer test on acid soil from Sussex. No. 554. Treatments: 30 phosphate; 3 potash; 31 phosphate and potash; 26 blank.

No. 618, Plot 6, Station farm at Madison. Cropped in rotation to corn, oats, seeded to clover, clover and potatoes, and manured on clover sod; not acid. Field test does not show the need of phosphates.

In a plant house test, the plant is forced to grow in a restricted area and will show the need of a certain fertilizer more quickly than in a field. The indication, then, may mean a future need and not an immediate one. In the plant house tests corn is used as the indicator because this plant grows rapidly and is more sensitive to the lack of any available element than almost any other crop. Whatever indication the corn shows, other crops will show in time, if not immediately.

The litmus paper test can be made in the field, if the soil is moist enough, by inserting a broad bladed knife into the ground and opening a slit wide enough to insert a rather long, narrow strip of litmus paper. With the knife blade the soil is pressed closely against the litmus paper and at the end of about three minutes the paper is carefully removed from the soil. If the paper shows red spots, the soil is acid. If the soil in the field is not moist enough for this test, a small portion of it may be placed in a porcelain dish, moistened to the right consistency with distilled water and worked up with a knife blade. By pressing a piece of litmus paper between two portions of the soil with the knife blade and leaving it three minutes, acidity or non-acidity will be shown by the presence or absence of red spots. In every case, whether in the field or in the laboratory, care should be taken that the hands touch the soil as little as possible, because perspiration will turn blue litmus paper red, and lead to erroneous conclusions. The knife blade, the distilled water, and the porcelain dish should be tested to see that they are free from acid.

From the above facts, it seems reasonable to draw the conclusion that *acid soils need phosphates,* and it will be possible, by a careful test of a soil with litmus paper, to tell if it needs, or will need in the immediate future, a phosphate fertilizer.

The reason for this need of phosphates in acid soils may possibly be found in the fact that acids dissolve phosphate minerals, and soil acids, whether due to decomposition of organic matter in the case of peat, or to long cultivation in the case of upland soils, will undoubtedly have a decided solvent action on phosphates in the soil, particularly on the calcium phosphates. When once in solution these phosphates are readily washed out by heavy rains. There is undoubtedly considerable phosphate material still remaining in acid soils, but it is at least unavailable to the plant and it is possible that it may be a phosphate of iron, or aluminium, such as dufrenite or wavellite, insoluble in weak acids.

Out of sixteen soils needing phosphates, thirteen are acid, indicating that not only do all acid soils need phosphates, but

also that a large majority of soils needing phosphates are acid. The three exceptions which need phosphates, but are not acid, are Nos. 111, 553, and 555, the first named needing phosphates most strikingly. It is possible that these soils have practically all their phosphates in the insoluble iron or aluminium form, as mentioned above in the case of the unavailable phosphates in acid soils.

Soils not acid probably contain considerable calcium and magnesium carbonates which, going into solution as the bicarbonates in water charged with carbon dioxide, serve to retain the phosphorus in the form of tricalcium phosphate, relatively insoluble in the soil moisture, and yet soluble enough to supply the needs of the growing crop.

II. ACID SOILS AND AMOUNT OF CARBONATES.

Acid soils must be lacking in carbonates since particles of limestone—calcium and magnesium carbonates—are almost, if not wholly, the only alkaline material in the soils of humid regions which corrects acidity. When these carbonates fall below a certain percentage, the soil is in such condition that acidity may develop. A determination of the carbon dioxide in carbonates of soils that are acid, and of soils that are not acid should give, in a general way, the point at which acidity is to be expected.

Although the litmus paper test is criticized as a correct indication of soil acidity, the experience of this Department has been such that great confidence is placed in it, and this test is the one relied upon to give the condition of the soils in the following work.

The samples used in Part I, on "Soil Acidity as an Indication of Lack of Available Phosphates," were all examined for carbon dioxide and in addition nine other soils, all of them acid, namely Nos. 177, 178, 182, and 183 from Lancaster; Nos. 212, 213, and 214 from Chippewa Falls; No. 215 from Westby and No. 216 from Viroqua. The method employed for the determination of carbon dioxide was the usual one for lime-

stone except that phosphoric acid (1:10) was used to decompose the carbonates instead of sulphuric acid or hydrochloric acid.

Professor E. H. Miller, of Columbia University, recommended the use of phosphoric acid whenever the limestone contains organic matter. Soils contain considerably more organic matter than limestone, and consequently it was thought best to use this acid. Tests on dried, precipitated calcium carbonate and finely ground, ignited quartz showed that phosphoric acid disengaged the same amount of carbon dioxide as did hydrochloric acid (1:4).

The apparatus consists, first, of two guard bottles filled with fifty per cent caustic potash solution, then a four hundred cubic centimeter, short necked flask with dropping funnel, attached by a long tube cooled with wet filter paper to a U tube containing silver sulphate solution,* then a bottle containing concentrated sulphuric acid and a U tube containing granulated calcium chloride. At this point is inserted a weighed Geissler bulb containing fifty per cent caustic potash solution, then a guard tube containing granulated calcium chloride and solid caustic potash attached to an aspirator capable of drawing two liters of air through the apparatus. The determinations are made in duplicate on ten and twenty-five grams of the soil that has been ground down to one hundred mesh size. The weighed soil is placed in the flask, and after clearing the apparatus of all carbon dioxide by drawing two liters of carbon dioxide free air through it, fifty or seventy-five cubic centimeters of acid, depending upon the amount of soil used, are run in by means of the dropping funnel. The rubber tube connecting the guard bottles with the flask is closed by a pinch cock, and the flask is gently heated until the boiling point is reached. After boiling about five minutes to insure thorough decomposition of the carbonates, the aspirator is attached, the heat removed and the pinch cock on the tube connecting the guard bottles with the flask is opened. Two liters of carbon dioxide free air

* Not absolutely necessary in this determination.

are now drawn through to clean out the apparatus. Finally, the Geissler bulb is weighed again, after leaving it in the balance case for half an hour, and the increase in weight is the carbon dioxide set free.

The following table gives in the first column the condition of the soil, whether acid or not, the second column the percentage of carbon dioxide calculated to the dry basis, and in the third column, the percentage of calcium carbonate calculated from the carbon dioxide. It is understood, of course, that the carbon dioxide may also be combined as magnesium carbonate.

TABLE I.—*Carbon dioxide and calcium carbonate in 100 mesh samples.*

Laboratory number of sample.	Condition of soil.	Carbon dioxide.	Calcium carbonate.
		Per cent	Per cent
74	Acid	0.017	0.039
84	Acid	0.033	0.075
62	Acid	0.491	....
239	Acid	0.031	0.071
244	Acid	0.037	0.084
246	Acid	0.019	0.043
277	Acid	0.031	0.071
293	Acid	0.026	0.059
297	Acid	0.047	0.107
177	Acid	0.029	0.066
178	Acid	0.034	0.077
182	Acid	0.044	0.100
183	Acid	0.044	0.100
212	Acid	0.024	0.055
213	Acid	0.038	0.086
214	Acid	0.021	0.048
215	Acid	0.044	0.100
216	Acid	0.045	0.102
551	Acid	0.036	0.082
552	Acid	0.029	0.066
554	Acid	0.040	0.091
556	Acid	0.029	0.066
111	not acid	0.111	0.253
102	not acid	0.120	0.273
124	not acid	0.034	0.077
618	not acid	0.176	0.400
553	not acid	0.098	0.223
555	not acid	0.011	0.025

As a further check in the case of certain samples, a determination was run on material of twenty mesh size. No. 246 was chosen as being low in carbon dioxide for acid soils; Nos. 618 and 124, as containing a high and low carbon dioxide content respectively for soils not acid; and No. 553 as being not acid and of medium carbon dioxide content.

The results compared with those on the 100 mesh samples are as follows:—

TABLE II.—*Carbon dioxide in 20 mesh samples compared with carbon dioxide in 100 mesh samples.*

Laboratory number of sample.	On 20 mesh samples.	On 100 mesh samples.
246	0.014	0.019
618	0.185	0.176
124	0.034	0.034
553	0.103	0.098

It will be seen that the analyses on twenty mesh samples practically duplicate those on the one hundred mesh samples.

Considering the various amounts of carbon dioxide, it is plain in every case where the soil is acid that carbon dioxide is low, except in No. 62. Where the soil is not acid the carbon dioxide content is relatively high, except in Nos. 124 and 555. Averaging the twenty-one acid soils, excluding No. 62, we find .033 per cent of carbon dioxide; averaging the six non-acid soils we find.092 per cent of carbon dioxide. There is almost three times as much carbon dioxide in the non-acid as in the acid soils. No. 62 runs exceptionally high in carbon dioxide. It is a peat soil containing almost eighty per cent of organic matter, which, in all probability, is of such a character that even phosphoric acid breaks down some easily decomposable compound resembling oxalic acid, and sets free carbon dioxide. It would undoubtedly be incorrect to express the result as calcium carbonate because the peat is underlaid by sand and there is no limestone in the vicinity from which carbonates can be derived. Moreover, this peat is much more acid than any other soil tested.

To be more specific, the above results indicate that whenever a soil falls below .11 per cent of calcium carbonate content, it will be acid, or at least in a condition to become acid very soon. Since calcium carbonate is not the only carbonate present, it would be more correct to express the figures in other terms and say that .05 per cent carbon dioxide is the critical

point. Soils not acid may fall below this figure in carbon dioxide content, as in the case of Nos. 124 and 555. These two soils are in the region of the last glacial clay on limestone and their lack of acidity may be due to the neutralizing effect of a local diffusion of alkaline solution from the limestone, there not being a sufficient amount of limestone particles actually present in the soil to raise the content of carbon dioxide above .05 per cent. Other soils in the same region may actually contain some limestone particles, as No. 618 for example, a soil lying near No. 124; or may even be acid, as in the case of No. 554, lying near No. 555, and of No. 556, lying at some distance from both No. 124 and No. 555.

FIELD EXPERIMENTS.

A. R. WHITSON, E. J. DELWICHE, AND E. R. JONES.

SANDY SOILS.

Field experiments were started this year on two classes of sandy soils; one at Sparta on the residual sandy soils from Potsdam sandstone, and the other at Iron River on glacial sands. Complete analyses of soils from these fields have not yet been made, but the difference between these two classes is shown in the analysis of soil from Black River Falls, and from Lac du Flambeau, given in the Twenty-Second Annual Report, pages 268–269. The soil from Black River Falls is similar to that at Sparta and that at Lac du Flambeau to that at Iron River. From the analyses above referred to, it will be seen that these two soils differ very greatly in that the glacial sand contains a much higher percentage of potash, phosphoric acid, and iron than does the residual sand. This difference in composition exerts a marked effect on the fertility of the soil, that of glacial origin being naturally more fertile than the residual sand when they have the same physical composition.

In general, sandy soils are low in water holding capacity, and this can only be increased by the addition of humus. This lack of humus also means a deficiency of nitrogen. An important part of the field experiment will therefore consist of a study of the relative merits of different crops, generally legumes, for adding humus and nitrogen.

Believing, as we do, that practical experience indicates that a considerable part of the essential mineral elements used by

any one crop comes from that set free by the decomposition of organic matter during the period of growth of the crop concerned, we have also undertaken the study of the development of a humus containing relatively large amounts of the essential elements by the use of the cheapest form of artificial fertilizers containing these elements. This will include the study of the untreated ground rock phosphate as a source of phosphorus and of ground granite as a source of potash.

The existence of large amounts of peat in the areas of sandy soils of both classes, above mentioned, makes it desirable to make a practical determination of its value for adding the humus and nitrogen to the soil. Since the region is one not adapted, in general, to stock raising, but to the production of special crops, it is particularly desirable to know the value and need of artificial fertilizers for the chief crops, and this line of study is included in our plans.

Another source of difficulty with sands arises from the fact that they are readily blown by the winds in the spring and early summer, causing great injury to crops, and our work will include a study of methods of preventing this injury. Incidentally, these field experiments will also give us an opportunity to study the fundamental processes of plant nutrition and soil fertility under field conditions.

1. EXPERIMENTS AT SPARTA.

The field selected for the study of the residual sandy soils of the central part of the state is located about 2½ miles east of Sparta on the farm of Mr. W. H. Smith. This field is very level and exceptionally uniform in texture, which is that of a medium coarse sand. This land has been in possession of Mr. Smith for forty years and for a large part of that time has been cropped to rye. About six crops of corn have been raised on it, mostly during the earlier years. Buckwheat was grown twice. Only one acre of the field ever received any manure whatever and that but once. One crop of rye was plowed under. The earlier yields were about twenty bushels

of rye per acre and from twenty to thirty baskets of ear corn per acre. The crops of rye the last few years have been exceptionally small, running from seven to ten bushels per acre, the last crop being seven bushels. In 1904 the west end of the field was planted to corn, and the entire yield of fodder amounted to about four loads on the eight acres. It was then seeded down to timothy, and, in 1905 the yield was not over five hundred pounds to the acre. It is evident, therefore, that this piece of land is about as completely exhausted in fertility as it is possible for soil to be, so that if any method can be found for developing its fertility economically, that method should be successful in dealing with all soils of this type.

In the spring of 1906, this field was laid out in fields and plots for experimental work.

Platting of field and treatment.—The south side of the area is divided into three fields which will be kept in a rotation of corn and potatoes, oats seeded to clover, and clover. Complete fertilizer experiments will be made on this land, including that of peat as a source of nitrogen. Methods of cultivation to lessen effect of wind blowing will also be carried on on this ground.

The north side of the land is also laid out in three fields, each of which is platted for the most promising legumes and across which the fertilizers are applied on sub-plots one being manured, the second treated with phosphate and potash alone, the third, with these two accompanied by ground limestone, the fourth, with ground limestone alone, and the fifth is left blank.

Treatment and history during 1906. Plot A.—The fertilizers were applied on the 10th of April and the land plowed from the 10th to 12th. Oats and clover were sown on the 13th. The clover made practically no catch and there was only a very poor growth of oats. The effect of the wind from the west was very marked, the oats being seriously injured over the entire field with the exception of a strip a few rods in width on the west end. No effect was noticeable from the application of fertilizers except that of manure and peat with phosphate and potash

added. On the 19th of July, when the oats were in the "milk" stage, an estimate was made of the respective yields in bushels per acre, simply to serve as a basis of expressing the relative growth made on the different sub-plots. This was as follows:—

TABLE I.—*Treatment and estimated yield of oats on sand field at Sparta, 1906.*

Number of plot.	Treatment.	Yield.
		Bushels
1	Limestone, potash and acid phosphate	16
2	Potash and acid phosphate	10
3	Blank	8
4	Limestone	8
5	Peat, potash and acid phosphate	15
6	Manure	18
7	Acid phosphate	8
8	Blank	8
9	Limestone and acid phosphate	8
10	Limestone and potash	11
11	Potash	11

It will be seen from this that in Plot 1, where the soil is protected from the wind by the fence and bushes, the crop made a low medium growth. On all other plots, except 5 and 6, the growth is extremely poor, not averaging more than sixteen to eighteen inches in height. On Plot 5, the average height was about two feet; on Plot 6 about two feet three inches, and of much better color. These results indicate clearly that the chief lack in this soil at present for such crops as oats is nitrogen or nitrates. The clover failed to catch. It was evident that the entire crop would have little value for harvest and it was therefore plowed under about the middle of August, and the field sown to rape at the rate of five pounds of seed per acre on the 22d of the month. The rape, however, has made a very poor growth.

Plot B.—This plot was laid out similarly to Plot A and the fertilizers applied April 10, and plowed April 10 to 12.

Corn.—Smut-nose corn was planted on the south one-half of the field May 25, in hills three feet six inches by three feet eight inches apart. The growth of corn was extremely poor on all except Sub-plots 5 and 6. On the 22d of August the aver-

age height of the corn of all sub-plots except 5 and 6 was two and one-half feet and the stalks were very slender and had but a few small ears. On Sub-plot 5 the average height was five feet and the color was very much darker than that of the others. On Sub-plot 6 the average height was $6\frac{1}{2}$ feet. Determinations of the yield on Plots 3, 5, 6, and 7 were made and gave the following yield in bushels of dry shelled corn having $12\frac{1}{2}$ per cent of water, per acre. .

TABLE II.—*Yield of corn in bushels per acre on the sand soil at Sparta.*

Number of plot.	Treatment.	Yield.
		Bushels
3	Blank	7
5	Peat, potash and acid phosphate	24.1
6	Manure	38.7
7	Acid phosphate	9.5

Here again it is evident that the most serious lack is of nitrogen. It is also seen that the peat, with phosphate and potash fertilizers added, is not equivalent to farm-yard manure when applied at the rate given, but in this connection it should be recalled that the peat was applied only a short time before planting and that it will doubtless require a longer period to be nitrified. It is evident, however, that a considerable amount of nitrogen of the peat did become available to the crop. No determinations were made of the other sub-plots, but there was little difference between them and Plots 3 and 7.

Figures 16 and 17 show the corn grown on Plots 3, 5, and 6.

Potatoes.—The north side of Plot B was planted to potatoes May 24 and 25, following the application of the fertilizers, and plowed on the same days as that for the corn above mentioned. Potatoes were planted in rows three feet six inches and in hills two feet six inches apart. The effect of fertilizers applied was similar to that described above for corn, except that the application of peat did not seem to be so beneficial. The yield of the sub-plots is given in the following table:—

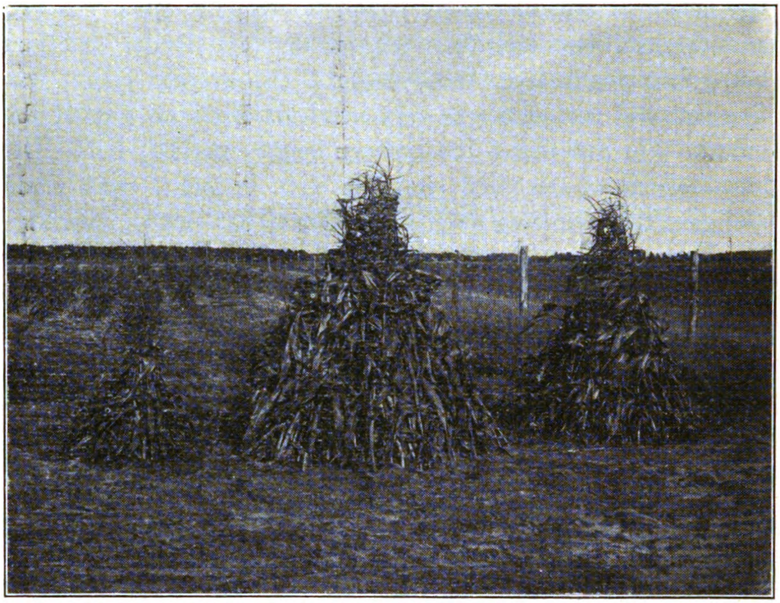

Fig. 16.—Corn grown on sand at Sparta; the shock at the left on untreated plot, the middle shock on manured plot and the shock at the right on plot treated with peat, phosphate, and potash.

Fig. 17.—Corn growing on sand at Sparta; that at the right on untreated land, that at the left on manured land.

TABLE III.—*The yield in bushels per acre of large and small potatoes on the Sparta sand field in 1906.*

Plot.	Large.	Small.
1	7.6	50.4
2	6.3	45.5
3	4.2	38.0
4	5.1	34.2
5	17.0	44.2
6	71.4	61.9
7	3.8	36.1
8	2.5	34.2
9	3.8	33.4
10	3.9	42.4
11	2.0	31.5

It is evident that the application of phosphate and potash fertilizers will be of little aid on this soil until the nitrogen has been increased.

Plot C.—This plot was sown to barley on the 20th of April. The effect of the sand blown from the corn and potato land was quite marked, but the fertility of the soil is so slight that an extremely poor growth was made, except where the fertilizers contained nitrogen. An estimate made on July 9, when the barley was in the "milk," was that on Plots 1, 2, 3, 4, 7, and 9, the yield could not be more than four or five bushels per acre; the average height was about one foot. On plot 5 the yield was estimated at twelve bushels and on 6, at twenty bushels per acre. Plots 10 and 11 were somewhat more advanced than the first four and were estimated to yield about eight bushels per acre.

This crop was plowed under on the 12th of July and buckwheat sown about the 20th. On the 22d of August, the buckwheat on all sub-plots except 5 and 6 had an average height of fourteen inches, and was in full bloom and quite thick on the ground. On Sub-plot 5, to which peat had been applied, the buskwheat made the poorest growth of that on any of the sub-plots, possibly because the peat prevented the proper placing of the seed in the ground by the drill. The height on that sub-plot was only about ten inches. On Sub-plot 6 the average height was seventeen inches. This crop of buckwheat was plowed under on the 5th of September and the field sown to

rye on the 12th, the plan being to plow this under the coming spring and plant the field to corn and potatoes.

North side plots.—Fertilizers were applied on these plots the 15th of April, and the legumes, with the exception of cow peas, sown from the 20th to 25th. The extremely low amount of nitrogen in the soil was manifest in the growth of these crops, and none of them developed tubercles to any considerable degree this year. The seed of the yellow lupine was extremely poor, so that no information whatever could be gained regarding the value of this legume this year. The seradella germinated well and developed a good stand but grew very slowly, so that on the 22d of August its average height was only about three inches. All of the other legumes made a very poor growth.

From the fact that these legumes were sown without a nurse crop, as was desirable in order to study the influence of fertilizers on them, the land became quite weedy, especially with pigeon grass.

On June 6, the plot originally sown to sand lucern, on which the germination had been very poor, was seeded to alsike. Crimson clover on Plot F, and cow peas on all of the other three plots were reseeded June 6. The cow peas grew better than any of the other legumes and on the 22d of August had a height of about ten inches with a fair stand on the ground. All other sub-plots were plowed under September 1, and sown to rye. The cow peas showed the influence of the manure and were also better on the plot to which rock phosphate, potash, and ground limestone had been applied than on that to which only the phosphate and potash had been applied, indicating that there was a beneficial effect of the limestone.

2. EXPERIMENTS AT IRON RIVER.

The field used for experimental work on the sands of glacial origin is located on the farm of Mr. J. A. Pettingill at Iron River, where it forms a part of the northern Sub-Station located at that place. The land has a distinct slope to the north

and east, and the sand is of granitic origin, containing grains of unweathered feldspar, mica, and other minerals as well as of quartz, with a small amount of silt and clay. This field had been in grain, seeded to clover in 1905, and was plowed in April of this year.

The chief problem on this field, as on that at Sparta, will be the retaining of a sufficient supply of humus to give the soil good water holding capacity. A full fertilizer test of the requirements of this soil for the mineral elements, potassium and phosphorus is also included in the experiment. The possibility of replacing the farm-yard manure as a fertilizer by peat, supplemented with rock phosphate and potash fertilizers, will also be studied.

Accordingly, this field, of about four and one-half acres in area, has been sub-divided into four rotation plots, approximately an acre each to provide for a rotation of crops. This rotation will eventually consist of, first, corn and potatoes, second, oats seeded to clover, third and fourth, clover. Only the first two of these were started this year, while plots 3 and 4 were sown to various legume and green manuring crops. Across all of the rotation plots fertilizer sub-plots, eleven in number, extend. The fertilizer sub-plots are numbered as follows:—

1, potassium sulphate; 2, potassium sulphate and ground limestone; 3, acid phosphate and ground limestone; 4, blank; 5, acid phosphate; 6, peat, potassium sulphate and acid phosphate; 7, barnyard manure; 8, calcium carbonate; 9, blank; 10, acid phosphate and potassium sulphate; 11, ground limestone, potassium sulphate and acid phosphate.

Rotation Plot 1, planted this year to corn and potatoes, is not full width, and on this plot fertilizer strips 1, 2 and 3 are omitted.

The entire field is somewhat variable in fertility, partly on account of variation in the soil and partly from the treatment it had received previous to being selected for experimental purposes.

Potatoes.—The yield of marketable potatoes per acre on the fertilizer Plots 4 to 11 inclusive, is as follows:—

TABLE IV.—*Yield of marketable potatoes at Iron River.*

Number of plot.	Bushels per acre.	Number of plot.	Bushels per acre.
4	195.2	9	128.0
5	217.6	10	169.8
6	244.8	11	163.2
7	206.4		
8	196.8		

From this it will be seen that the smallest yield is that on Plot 9, to which no fertilizer was applied, and the largest, that on Plot 6, to which peat, phosphate, and potash were applied. The yields, however, are so variable that not much weight can be given to the variation found.

Corn.—Wisconsin No. 8 corn, a very early yellow dent variety was planted June 8 three feet eight inches apart each way, four kernels to the hill, and was cut the 21st to 25th of September. The corn was husked about three weeks later, at which time it was estimated that 75 pounds of ear corn would be equal to a bushel of shelled corn with 12 per cent water. On this basis the yield per acre is given in the following table:—

TABLE V.—*The yield of corn per acre on fertilizer plots at Iron River.*

Number of plot.	Yield in bushels per acre.	Number of plot.	Yield in bushels per acre.
4	39.2	8	43.5
5	47.3	9	34.7
6	51.5	10	36.2
7	50.1	11	28.3

The variation in the natural fertility of the field is, apparently, considerable so that little weight can be given to the yield of the variously treated plots this season.

Oats.—Plot 2 was seeded May 2 to Swedish select oats (Wisconsin No. 4) at the rate of two and one-fourth bushels per acre. The oats made fair growth but were greatly retarded by the dry weather in August. The fertilizer plots were not harvested separately, but the effect of the peat and manure was very noticeable on the plots to which they were applied.

The alfalfa and clover sown with the oats did not make a good catch and the field was plowed after harvest. A second application of the fertilizers was then made, including the use of nitrate of soda on Sub-plot A, to which only limestone had previously been applied. The field was then divided into four sub-plots and sown to rape, rye, crimson clover, and buckwheat respectively for the purpose of testing these plants as catch crops. At present writing all are doing well with the exception of the crimson clover, which is not making a good growth.

Plot 3 was divided into five sub-plots on which alfalfa, sand lucern, alsike clover, cow peas, and yellow lupines were sown to test their value as green manuring crops. This seed was sown the 23d of April. A heavy frost occurred on the 28th of May, which affected the cow peas, and the plot was reseeded. The yellow lupine seed being of very poor quality did not germinate well and the plot was seeded to soy beans.

Plot 4 was also divided into five sub-plots and seeded to crimson clover, seradella, sand vetch, yellow lupine, and Canada field peas. Nothing of importance concerning the value of these crops as nitrogen gatherers can be determined in less than two years' time.

EXPERIMENTS ON MARSH SOIL.

The desirability of reclaiming and developing marsh lands depends on the expense of draining them and on their fertility after being drained.

Considerable study has been given to the drainage of the various classes of marsh and other wet lands of the state during the past two years. Part of the results of this study are given in Bulletin No. 138—Land Drainage—and the remainder will be published in another bulletin to be issued soon.

A study of the fertility of peat soil was begun on an experimental field at Marinette in 1904, and the results are given in the Twenty-First Annual Report, page 211, and in the Twenty-Second Annual Report, page 275. This year, experimental fields on peat have also been laid out at Phillips and Mather. So far, however, it has been impossible to get sufficiently well-

drained land of this type for experimental purposes. The fields at Phillips and Mather, however, are now well drained and the field at Marinette is within a district now being organized and within which work will probably be done the coming year. On account of this lack of drainage it has been impossible to experiment, to any extent, with other crops than hay grasses. A small field of barley was sown at Phillips this year, and one of potatoes planted at Mather.

1. MARINETTE.

A description of the experiments started on this land last year is given in the last annual report as above mentioned. Probably on account of lack of sufficient drainage, fowl meadow grass was the only one of the four varieties seeded in the spring of 1905 to survive the winter. Dressings of sulphate of potash at the rate of 136 pounds per acre and of acid phosphate at the rate of 250 pounds per acre were applied to this land in November, 1905, as shown in the following table, which also gives the yields of hay per acre for 1906.

TABLE VI.—*Treatments and yields of hay of fowl meadow grass plots at Marinette for 1906.*

Plot.	Treatment.	Pounds of hay per acre, 1906.
1	Potash, spring and fall 1905	1,024
2	Acid phosphate, spring and fall 1905	2,272
3	Potash and phosphate, spring and fall 1905	3,360
4	Blank	1,216
5	Manure, spring 1905	1,664
6	Potash and phosphate, spring 1905	3,040
7	Potash, spring 1905	1,312
8	Acid phosphate, spring 1905	2,048

These results indicate first, that phosphorus is the element most lacking in this soil, but that potash is also beneficial; second, that the application of the artificial fertilizers the second year did not greatly increase the crop. A conclusion should not be drawn from this, however, that the results on other grasses than fowl meadow would be the same.

The field sown to oats with timothy and alsike clover in the spring of 1905, as described on page 280 of the Twenty-Second Annual Report, produced a fair crop of hay this year with no additional fertilizer beyond that applied when the oats were sown except of potash on plots 1 and 3. The manured plot came up largely to redtop this year. The treatment and yields are given in the following table:—

TABLE VII.—*Treatment and yields of timothy and alsike clover at Marinette for 1906.*

Plot.	Treatment.	Pounds of hay per acre, 1906.
1	Potash, spring and fall 1905	1,968
2	Untreated rock phosphate, spring 1905	2,000
3	Untreated rock phosphate, spring 1905; Potash, spring and fall 1905	2,2[illegible]0
4	Blank	440
5	Manure, spring 1905	1,840
6	Untreated rock phosphate, spring 1905; Potash, spring 1905	2,112
7	Potash, spring 1905	1,760
8	Untreated rock phosphate, spring 1905	1,680

2. PHILLIPS.

The ground used for the experimental field in Price County is located on the farm of Mr. DeWitt Van Ostrand, about two miles south of Phillips. This field was originally a tamarack and spruce swamp and was cleared in 1901 and 1902. The soil is a very coarse peat, underlaid by clay, and covered with a dense mat of sphagnum moss.

Experimental work was done this year on three fields.

Field I.—Field No. 1 was cleared in 1904, the moss being burned off, and plowed in the fall. During the winter ashes were applied at the rate of three loads per acre. It was seeded in the spring of 1905 to alsike and timothy, and a good crop of hay was cut that year. In the spring of 1906. this field was sub-divided into eight sub-plots for fertilizer tests and the fertilizers used, together with the yield of hay per acre, are given in the following table:—

TABLE VIII.—*Treatment and yield of peat soil at Phillips, Price County.*

Plot.	Treatment.	Pounds of hay per acre, 1906.
O	Sulphate of potash 100 pounds per acre	4.588
P	Acid phosphate 275 pounds per acre	5,015
Q	Sulphate of potash 100 pounds per acre Acid phosphate 275 pounds per acre	4,848
R	Blank	2,727
S	Sulphate of potash 100 pounds per acre Acid phosphate 275 pounds per acre	4,906
T	Sulphate of potash 100 pounds per acre	4,781
U	Acid phosphate 275 pounds per acre	5,158
V	Manure 15 loads per acre.	2,476

Field II.—Part of this field had been plowed in 1903 and sown in 1904 without other treatment, but there was very poor growth. This part of the field was again plowed in the spring of 1905 and laid out in four sub-plots, treated respectively with potash, potash and phosphate, phosphate, and the fourth left without treatment. Across these sub-plots a strip was treated with ground limestone. The field was then sown to alsike and timothy. Very little growth took place on any of the plots, though the effect of limestone, which had been applied at the rate of six hundred pounds per acre, was quite noticeable. The entire field, including the part above mentioned, and a part which had not been plowed before, was plowed in the fall of 1905 and treated in the spring of 1906 with fertilizers in two groups, one being a repetition of the application made in 1905 and the other a duplication of this on the previously unplowed portion. Across both parts of the field, strips were seeded to redtop, timothy and alsike, tall meadow oat, and meadow fescue. Although this soil was in excellent condition, and had good drainage, practically no growth occurred except on the part to which limestone had been applied where a very slight growth took place. The entire field, however, became thoroughly covered with sorrel. From this experience it appears possible that the high degree of acidity in the soil is the cause of the failure of the grass seed to grow. Determinations of the acidity in this peat, however, do not indicate a very much larger amount than occurs in the peat at Marinette.

Lime not having been found beneficial at Marinette, it was not used at Phillips. In view of the above results, however, a thorough test of the effect of lime on this soil will be made the coming year.

Field III.—A small field, on part of which ashes at the rate of four loads per acre were applied, was sown to barley. The barlev grew exceptionally well on the part treated with ashes but made absolutely no growth on the untreated portion. On account of the very thin seeding, the crop was light, being only 22.3 bushels per acre, but was of an exceptionally good quality and stood up well and had heads of good length.

3. MATHER.

A coöperative experiment was carried on with Mr. Geo. A. Marvin on the peat marsh at Mather, adjoining the large ditch of the Beaver Drainage District. This soil is a coarse peat of about one foot in depth underlaid by two to three feet of muck, and the whole overlying coarse sand. The ditch at the side of the field is eight feet in depth; so the field has had excellent drainage. On this land a field of about one acre was laid out into strips to which fertilizers were applied, and sub-plots, running across these strips, sown to hay grasses, buckwheat seeded to timothy and alsike, and potatoes. The effect of phosphate and potash on grasses is quite marked, especially the phosphate. On account of lodging it was necessary to cut the buckwheat before it was ripe to prevent it killing the timothy and alsike.

The potatoes did exceptionally well and gave yields expressed in the following table:—

TABLE IX.—*Treatment and yield of marketable potatoes on plot at Mather in 1906.*

Sub-plots.	Treatment.	Yield in bushels per acre.
1	Sulphate of potash, 100 pounds per acre	178.5
2	Sulphate of potash, 100 pounds per acre; Acid phosphate, 300 pounds per acre	201.1
3	Acid phospate 300 pounds per acre	229.5
4	Blank	141.5
5	Manure, 15 loads per acre	232.5

Although there appears to be some variation in the natural fertility of the field itself, it is very evident that phosphate is extremely beneficial on this land.

RED CLAY SOILS OF SUPERIOR REGION.

Red clay soils cover an area of from five to twenty-five miles in width extending along the south shore of Lake Superior, from Superior to Hurley. Without attempting a complete description of this soil, it may be said that there are two phases of the clay. The first is a glacial till, having an undulating topography and the second is clay deposited in the former extension of the lake and forming a plain sloping towards the lake. Into this plain streams have cut numerous narrow and deep channels, but between these streams the land is quite flat. The clayey nature of the soil on both parts of this area makes its under-drainage rather poor naturally and this is especially true of the flatter or lacustrine portion. While the soil is one of high natural fertility, this lack of thorough under-drainage, together with the cold weather to which that region is subject in the spring, keeps the soil cold and retards the chemical changes which produce fertility. One of the most important improvements in this soil is, therefore, its under-drainage.

The cold, wet condition in which the soils existed in their virgin state is not favorable to the development of bacteria and other organisms essential to lasting fertility, and it is very probable that surface dressings of manure will be helpful in improving the soil in this respect. This matter will also be made

an object of study. The texture of the soil can also, in all probability, be improved by the addition of humus, chiefly produced by the growth of grasses and clovers.

Two of the northern sub-stations have been selected on this red clay soil, as mentioned in the Director's report, page 10. One is at Superior, on the flat or lacustrine type, and the other at Ashland, on land having a better surface drainage.

1. SUPERIOR.

The field of the Superior sub-station is on the County Poor Farm, two miles southeast of Itasca. The portion devoted to soil studies includes about nine acres, which have been cleared some years, and on which volunteer grass had been cut for hay. The field is very flat and has poor surface and under-drainage. The field was divided into four sections for drainage experiments. On the first, lines of tile drains were put in forty feet apart; on the second, they were placed sixty feet apart; on the third, eighty feet apart; and the fourth was left without tile drainage for comparison. The plot on which tiles were closest together had been originally somewhat wetter than the untiled portion. So far as possible, equal surface drainage was given to all plots. The lines of tile were laid late in the fall of 1905 at an average depth of two and one-half feet, being about two feet in depth at the end farthest from the main, and three feet in depth where they joined the main. The tiles discharged some water during a large part of the winter and the ground on the tile drained portions, especially where the tiles were closest, was much firmer and drier this spring. This field was then laid out in three lands, running across the lines of tile, to provide for a three-year rotation of crops, consisting of first, cultivated crops, corn, potatoes, and sugar beets; second, grain seeded to clover; and third, clover. This arrangement makes it possible to study the effect of the various degrees of drainage on each crop every year.

The land was still so wet and cold this spring that very little growth of grain was made, and the crop was cut for hay.

Later on the effect of drainage became more marked, and corn was planted on the field planned for cultivated crops in order to determine what the influence of drainage would be, although it was not expected that corn could mature. It was planted on the 11th of June and cut on the 25th of September, at which time the ears were still quite soft. The effect of drainage on the corn, however, was very marked. The influence was of two kinds, first on the germination of the seed, and, therefore, on the stand of corn, and second, on the growth of that which did germinate. The per cent of stand and the height of corn at the time of cutting are given in the following table:—

TABLE X.—*The per cent of germination and height of corn on drainage experiment field at Superior, Douglas County.*

Distance between tile in feet......	40	60	80	No tile
Per cent of "stand"...............	95.	80.	40.	25.
Average height September 25 in feet............................	5.8	5.6	5	4

The corn growing on three areas, each 30 by 142 feet, the first of which was on the undrained section, the second on the strip between those where the tiles were 80 and 60 feet apart respectively, *i. e.,* where the tiles were 70 feet apart, and the third on the section where the tile lines were 40 feet apart, was cut and shocked so as to be photographed. Figure 18 shows the product of these three areas and illustrates very strikingly the effect of tile drainage on this heavy clay soil.

The clover started very well and shows a marked influence of the drainage.

2. ASHLAND.

The sub-station at Ashland is located one mile east of the city. The field devoted to soil studies is gently undulating and the lower portions are quite wet, while the higher portions have fair drainage. Three fields have been laid out on this land for soil studies, on the first of which lines of tile have been

Fig. 18.—Corn grown on equal areas of heavy red clay at Superior, having different degrees of drainage as indicated in the cut.

laid through the lower portions without a regular system. The second field is left undrained for comparison, while the third will be used for fertilizer tests. The tile was laid during the latter part of the present summer, so that there are no results to report this season.

TOBACCO INVESTIGATION.

E. P. SANDSTEN.

The present high price of Wisconsin grown tobacco has caused an intense interest among the farmers in the tobacco growing sections, and it is confidently expected that the acreage devoted to tobacco growing will increase greatly during the next few years. The present high prices, which have continued for two years, are due to the shortage of this particular kind of tobacco and to the increase in consumption, and it is to be expected that this demand will continue for several years to come, if not permanently. The prices three years ago ranged from four to twelve cents per pound, with an average of about seven. Last year the price rose to fifteen cents per pound for the best quality, and this year most of the crop has been sold for prices ranging from ten to sixteen cents per pound, with the prospect of still higher prices before the crop is finally marketed. In view of this great increase, and the added interest in tobacco growing, the necessity for more careful study of the various problems associated with the economic production of a crop, is becoming more and more urgent. The present appropriation of $1,500.00 per annum is wholly inadequate to properly carry on the work. It is neither satisfactory to the investigator, nor to the tobacco grower. The appropriation should be large enough to support the services of a trained assistant.

The following problems have been studied during the last three years:

First, the improvement of Wisconsin tobacco by breeding and by selection.

Second, a study of the use and value of commercial fertilizers used exclusively, or supplementary to barn-yard manure.

Third, the use of cover crops as a soil ameliorator and fertilizer.

Fourth, the study of the proper handling and curing of the crop.

THE IMPROVEMENT OF WISCONSIN TOBACCO BY BREEDING AND SELECTION.

When the work was started three years ago, attention was called to the demand for a uniform type of tobacco. It was found that one farmer grew one variety, and another farmer another variety, causing the dealers an endless amount of trouble in sorting and grading, besides resulting in a mixed lot of tobacco. Lower prices were paid to the farmer and a smaller profit realized by the dealer. To improve this condition a consultation was held with a number of active dealers, and a variety of Connecticut Havana, Wisconsin grown, was selected as a type suited to Wisconsin conditions. From this variety, by careful selection of typical plants, seed has been grown three successive years under direct supervision of the Horticultural Department. As a result we have obtained a uniform variety of tobacco. During the last three years, over 400 pounds of seed of this variety have been distributed among the tobacco growers of this state, and flattering reports have been received from the growers. The seed has been grown in two different sections of the state, so as to meet the local requirements of the grower as nearly as possible. It is hoped that with the end of the present season, some reliable person or persons will take hold and supply the growers of the state with this particular variety of seed at regular market prices, thus relieving the Department of this work. This year about 300 pounds will be distributed.

Besides the work of improving Wisconsin tobacco by selection, a number of standard varieties have been crossed, the ob-

ject being to produce new types better adapted to Wisconsin conditions than the existing ones. As a result of these crosses, four or five promising varieties have been obtained.

In another year enough seed will be on hand of these new varieties to test them at several places in the state. The object in view has been to produce a broader and larger leaf, with a more rounded outline than the Connecticut Havana and, at the same time, maintain the high quality and compactness of this variety. How far these points will be realized can only be determined after more extended trials, but indications point to excellent results.

TOBACCO FERTILIZER.

The present system of farming in connection with tobacco growing is not to be recommended. Most of the barn-yard manure made on the farm is applied to the tobacco land, thus leaving an insufficient amount for the other farm crops. This system will eventually be a disastrous one to the farmer, and will lower the quality as well as the quantity of the other crops produced. To guard against the exhaustion of the soil, it will be necessary for the tobacco growers to use a certain amount of commercial fertilizer in connection with barn-yard manure; also to practice a system of rotation. After two years of experimenting with commercial fertilizer, we have come to the conclusion that if the amount of barn-yard manure (20 tons to the acre now ordinarily used on tobacco lands) be reduced to 10 tons and in addition 100 pounds of nitrate of soda, 150 pounds of sulphate of potash, and 200 pounds of desiccated bone be used to the acre, the result would be more satisfactory. The commercial fertilizers should be applied just before the plants are set, so as to give the young plants the benefit of their solubility. The slower acting barn-yard manure will carry the crop through the season. By this method of fertilizing, the other farm crops will be benefited to the extent of the commercial fertilizer purchased. It is poor economy, indeed, to rob one or more crops of their fertilizers in order to supply another. At the present high price of tobacco it will not be a hardship

to the farmer to purchase fertilizers, and besides the gain, both in the tobacco and other crops, will be correspondingly greater. It is not wise at present to use commercial fertilizers exclusively, as this practice would soon rob the soil of its humus, or vegetable matter, and at the same time gradually injure the quality and reduce the yield of tobacco.

We do not wish it to be understood that the farmer should purchase nitrates and potash in the form of nitrate of soda and sulphate of potash, though the two elements in these forms are as cheap as in any other form. Other kinds of fertilizers may be used, provided sufficiently large amounts are applied to furnish an equivalent of nitrogen and potash to that of nitrate of soda and sulphate of potash. Above all, the grower must avoid all fertilizers containing chlorides in any form, as the chlorides greatly injure the burning quality of the leaves; also, fertilizers containing a large amount of acid should be avoided.

It should not be understood that the amounts of fertilizers above given are equally effectual on all kinds of soil. The amounts given are for the average tobacco soils in the state. There are many soils which require larger amounts, and others that require smaller amounts. Further, the proper amount to apply to different pieces of land can only be arrived at by trials conducted by the farmers themselves, and these trials can be made on a relatively small scale. The results obtained in the Station experiments would only hold for the land on which the trials were made, and they can only serve as a basis for the farmer to work from.

The importance of these questions should be recognized by all growers of tobacco, and if tobacco growing is to continue as a profitable industry in the state, and is not to interfere with other crops, the grower must give more attention to the use of fertilizers, commercial and home-made, and must learn to study his own soil requirements.

COVER CROPS.

As a rule tobacco is planted on the same land year after year, generally because it is the best piece of land on the farm, and

also because it is easier to keep this land free of weeds. Tobacco being a heavy feeder, farmers are obliged to apply large quantities of barn-yard manure to keep up the fertility of the land, in order to produce a paying crop. On this account the rest of the farm crops do not receive a sufficient amount of barn-yard manure.

To study the question of cover crops as a supplementary fertilizer and as a soil improver, experiments have been conducted on the tobacco farm of E. M. Calkins, at Janesville.. The experiments have been carried on for two seasons with very satisfactory results. The crop selected was hairy vetch (Vicia villosa), a hardy legume. The seed was sown immediately after the tobacco was harvested, at the rate of 60 pounds to the acre, and cultivated in. The benefits from the cover crops were quite noticeable and Mr. Calkins is very enthusiastic over the possibilities of this crop as a fertilizer and soil ameliorator. Since the hairy vetch is not injured by frost, it continues to grow until late in the fall, and resumes growth as soon as the frost is out of the ground in the spring, producing a heavy mat of succulent vines which can be turned under in time for the setting out of the tobacco plants. Being a legume, the amount of nitrogen furnished by the cover crop is considerable and, besides, a large quantity of vegetable matter is added. The only drawback to an extended use of hairy vetch is the cost of the seed which is, at present, $7.55 per hundred pounds. Still, if the tobacco growers would use the cover crop in conjunction with the barn-yard manure considerable saving would result.

THE STUDY OF PROPER HANDLING AND CURING OF TOBACCO.

The growing of a crop of tobacco is only one step in the production of high-priced leaves. Many promising crops are spoiled entirely, or badly damaged, during harvesting and curing. It is here that the tobacco growers are at fault, since carelessness and indifference are largely responsible for the losses sustained, and closer and better attention must be given to these phases. Then too, the shed conditions in the state are, on the whole, unsatisfactory. A large share of the sheds in

tobacco growing sections are out of repair, and badly constructed as to ventilation and roofing. The shed problem is a most serious one, and one which demands immediate attention from the grower. No matter how promising the crop, it is easily destroyed, or badly damaged, if hung in a poor shed. The difference in value of a crop for a single season would more than pay for the expense of having the shed properly repaired.

To study the conditions of curing, a shed of the following dimensions was constructed at the Experiment Station this summer. Length, 60 feet; width, 28 feet; height to the eaves, 12 feet, with a ¾ pitched roof. A shed of these dimensions will hold about two acres of an average yield of 16 to 20 thousand pounds to the acre. The construction of this shed is very simple. The frame consists of 2x4's placed in the usual manner, convenient for hanging the tobacco. The sides are double, consisting of boards placed tightly on the frames, and a layer of building paper on top of these boards, over which drop-siding is placed, making a tight wall. The roof was constructed by placing boards closely together on the rafters, then a layer of building paper, and then shingles. There are six tin ventilators in the roof, which can be opened and closed by strings from the inside of the shed. Ventilation is provided by three parallel rows of ventilators, 12 inches wide, running horizontally along the shed, opened and sustained by means of hooks and eyes, and closed by buttons. These ventilators fit tightly, and the bottom of the shed is made tight by banking up with soil. The contractor's price for the shed described was $825.00, including painting, gutters, and water spouts. The shed is also provided with a system of heating, consisting of four parallel rows of 1½ inch pipes running the whole length of the shed and attached to an old threshing engine, which furnishes steam and heat as needed. At every 8 feet on these heating pipes pet-cocks are placed, which can be opened when needed for letting out steam. The cost of piping, and the necessary connections with the engine was $70.00, making the total cost of the shed and heating in the neighborhood of $900.00. This may seem a large outlay, but a shed constructed

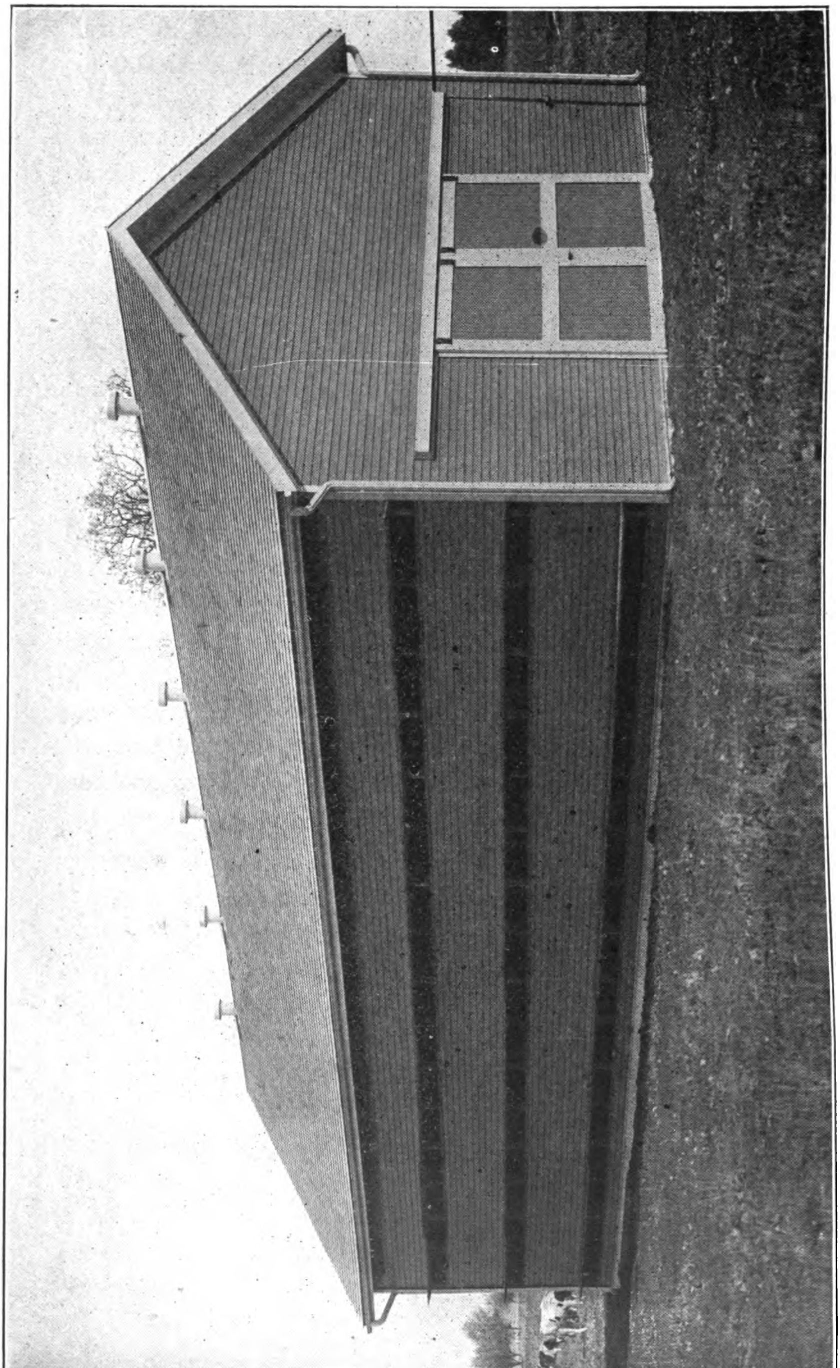

Fig. 19.—Model tobacco shed.

as above, if properly cared for, should last from 15 to 20 years. A conservative estimate would make the cost from $10.00 to $15.00 per running foot, including heating. (See Fig. 19).

With a system such as described, the curing conditions can be regulated absolutely, and a uniform and properly colored tobacco obtained; besides, the crop can be taken down at any time by using steam, thus eliminating the risk and danger of having to wait for favorable outside weather conditions.

Two acres of tobacco were grown on the Station farm this year and the crop harvested and placed in the new curing shed. The crop was badly damaged by the heavy rain storm during the night of August 17; four and one-half inches fell which, together with the heavy wind, threw the plants down and tore holes in the leaves, but this will not seriously interfere with the work in curing.

If Wisconsin tobacco is to maintain its position in the market and the industry is to expand, more attention must be given to the finer details of handling the crop, and the dealer should in turn recognize the difference in the value of tobacco well handled and properly cured and pay correspondingly higher prices for the same. There are degrees of quality and excellence in tobacco as much as there are in any other farm product.

POTATO SPRAYING EXPERIMENT.

E. P. SANDSTEN AND J. G. MILWARD.

Potatoes are one of the principal crops of the state. Over 30,000,000 bushels are annually grown. The industry is especially important in the central and north-western counties, where the soil is admirably suited for the production of a large crop having excellent cooking and keeping qualities. The soil being a sandy loam, is easy to cultivate and handle, and a large acreage can be grown at a relatively small cost. The greatest drawback to the growing of potatoes is the prevalency of early and late blight and potato scab. The early blight (Alternaria solani) has been particularly destructive during the past two seasons. The blight is not equally destructive; some years little or no damage is done, while other years damage amounting to 50 and even 75 per cent of the crop occurs. The fact that the blight does not appear every year causes the farmer to neglect spraying and take his chances.

To demonstrate the value of spraying against the blight, and to determine the actual cost under ordinary farm conditions, spraying experiments have been carried on for the past three years in the principal potato growing counties in the state. These experiments were conducted on large fields, using the latest and most improved power sprayers. The field work was done under the immediate charge of James G. Milward, and the success of the work is due in a large degree to his careful and conscientious work.

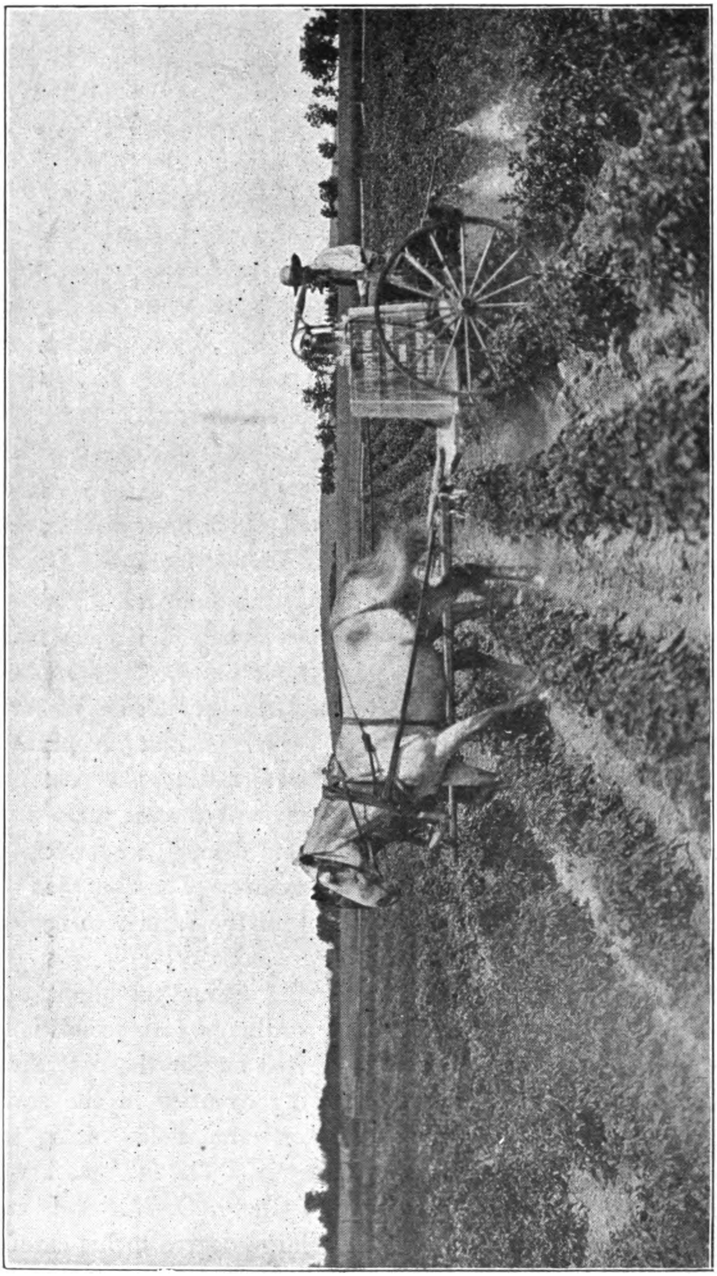

Fig. 20.—Side view of spraying machine in action. Capacity 40 acres per day. An efficient machine.

The first year's work (1904) was confined to Waupaca County, on a 37-acre potato field on the farm of Soren Jensen. This field was carefully laid out and sprayed in alternate strips, so as to get accurate and uniform results. Several farmers' meetings were held during the summer and instruction given in all the details of the work, such as making the Bordeaux mixture, time for application, etc. No blight occurred that year, and the results of the experiment were negative. The work was continued in 1905 on the farm of S. S. Chandler at Waupaca, Waupaca County, and at Colfax, in Dunn County. The weather conditions for the blight were very favorable, and it developed with great rapidity during August and September. From 50 to 75 per cent of the crop was destroyed. The sprayed fields were protected, and at harvest the increase of the sprayed over the unsprayed areas amounted to from 25 to 145 per cent, depending upon the season, number of applications and varieties grown. At the time of harvesting, a large farmers' meeting was held, at which the work was gone over in detail. The harvesting of the crop showed not only a larger yield, but higher grade tubers, the sprayed ones being not only larger, but cleaner and smoother.

During the past season the work was extended to Burnett, Portage, and Columbia counties. The results this year, while not as pronounced as the previous year, showed a gain from 20 to 50 per cent.

There can be no question that if the farmers had sprayed during the past two years, several million dollars would have been saved. Counting the yield for the state for a normal year at 30,000,000 bushels, with a loss of 50 per cent from blight, there would be a loss of 15,000,000 bushels; at 30 cents per bushel, it would amount to $4,500,000, or if we take the price at the time of digging in 1905, which was 55 to 60 cents, the gain would be nearly $8,000,000. While these figures are only relative, they serve to show the importance of spraying.

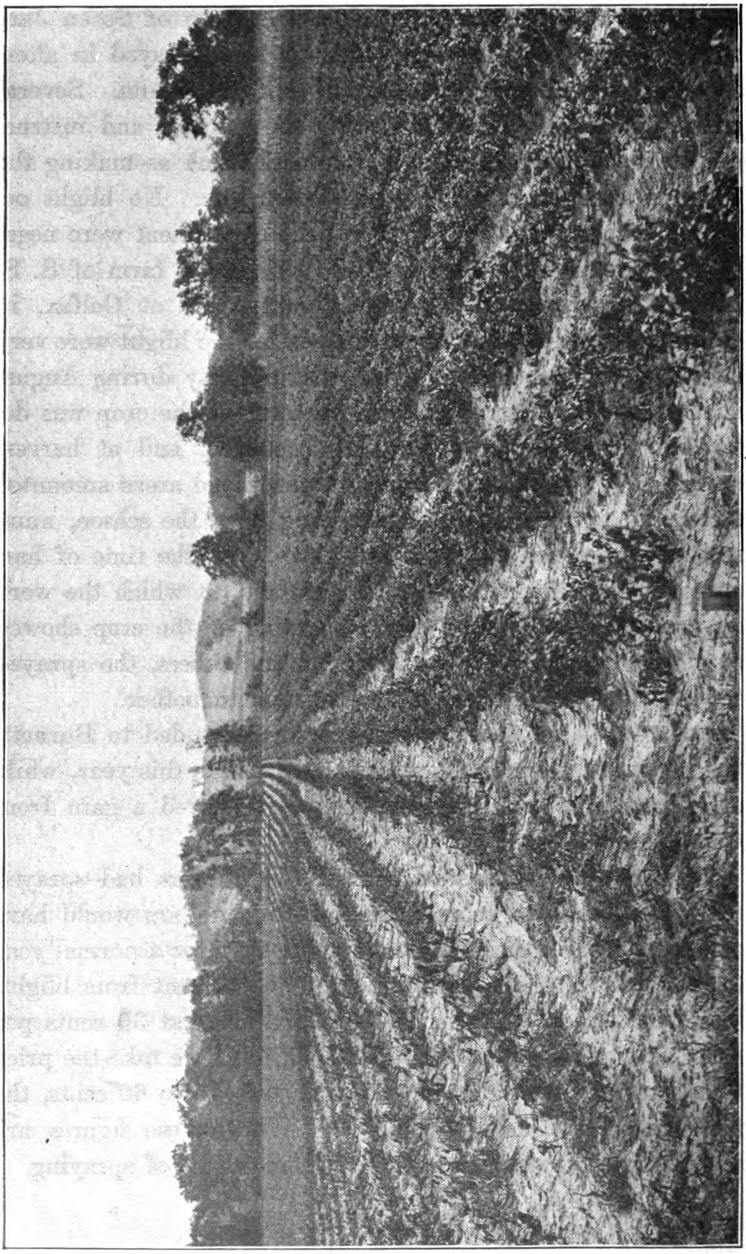

Fig. 21.—A portion of experimental field at Waupaca. Photograph taken September 18. To the right, the sprayed area was green and growing, while the vines on the unsprayed area were dead and dried.

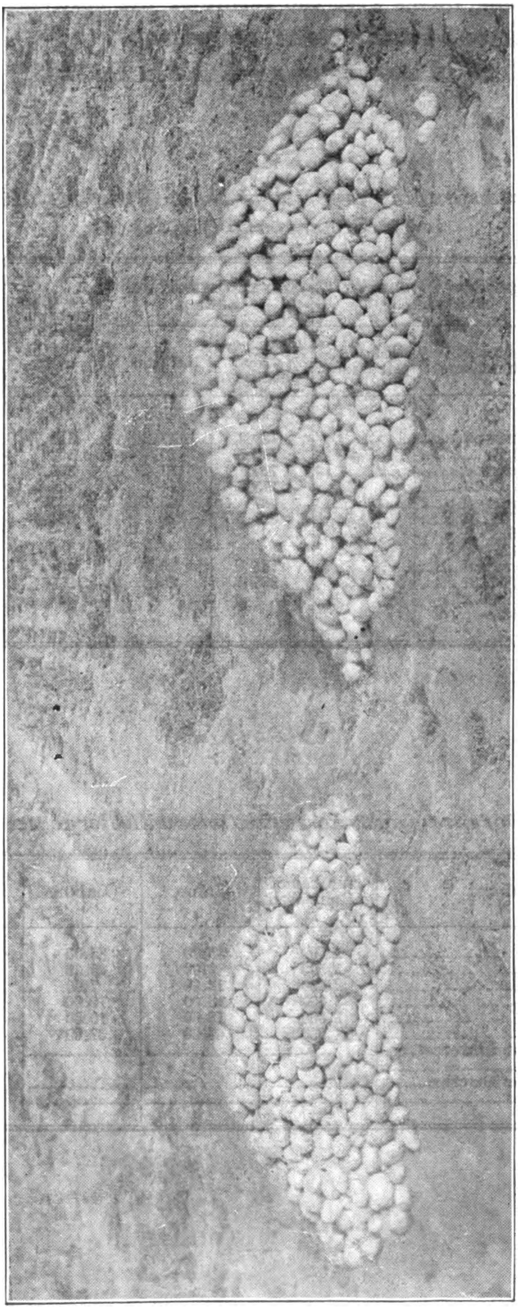

Fig. 22.—Actual yield from sprayed and unsprayed plots of equal size. Pile to the right sprayed. Pile to the left unsprayed.

The following tables give the result of the spraying experiments, and the cost for the past three years.

For more detailed statements see Bulletin No. 135.

TABLE I.—*Potato spraying experiment No. 1, Waupaca, 1905, showing treatments and yields.*

PLOTS.	TREATMENT BORDEAUX MIXTURE.		YIELD OF SAMPLE, AREAS.		Yield per acre of marketable potatoes.	Percentage gain over check plots.
	Dates of applications.	No. of applications.	Marketable potatoes.	Culls.		
			Lbs.	Lbs.	Bu.	
Check.....	Not sprayed	....	130.7	17.2	130.7	....
Plot I.....	July 3, 17.........	2	152.5	16 7	152	16.2 gain
Check.....	Not sprayed	....	130.7	17.2	130.7	....
Plot II....	July 3, 17, 31	3	175.5	14	175.5	43.8 gain
Check.....	Not sprayed	....	137	15.7	137	....
Plot III...	July 3, 17, 31 ..... Aug. 15. Sept. 12.	5	224.5	20	224.5	64.3 gain
Check.....	Not sprayed	....	161	16.5	161	....
Plot IV....	July 3, 17, 31 ..... Aug. 15, 28. Sept. 12.	6	255	20.2	255	58.3 gain

TABLE II.—*Cost of spraying 30 acres five times with Bordeaux mixture.*

Applications.	Number of gallons used.	Value.	Labor.	Totals.
First..............................	1,500	$9.00	$5.00	$14.00
Second..............................	1,500	9.00	5.00	14.00
Third..............................	2,000	12.00	7.00	19.00
Fourth..............................	3,000	18.00	10.00	28.00
Fifth..............................	3,000	18.00	10.00	28.00
Totals..............................	11,000	66.00	37.00	103.00
Wear on machine and interest, estimated	....	....	....	10.00
Grand total cost for 30 acres.......	....	....	....	113.00
Cost per acre.......................	....	....	....	3.70

TABLE III.—*Yield and profit of 30 acres of sprayed over 30 acres unsprayed, five applications.*

	Check plots.	Sprayed plots, five applications.
Average yield in bushels per acre.	150	240
Total yield for 30 acres in bushels	4,500	7,200
Total value of yield for 30 acres at 40c. per bushel	$1,800	$2,880
Gain in value over check plots for 30 acres	....	$1,080
Average gain in dollars per acre.	....	$36

TABLE IV.—*Potato spraying experiment, No. 2, Waupaca, 1905, showing treatments and yields.*

PLOTS.	TREATMENT WITH BORDEAUX MIXTURE.		YIELD OF SAMPLE AREAS.		Yield per acre of marketable potatoes.	Percentage gain or loss over check plots.
	Dates of application.	Number of applications.	Marketable potatoes.	Culls.		
			Lbs.	Lbs.	Bu.	
Check	Not sprayed.....	....	182.4	77.5	91.2	
Plot I ...	July 17, 31........	2	191	40	95.5	4.7 gain
Check	Not sprayed......	....	235	34.2	116	
Plot II	July 17, 31........ Aug. 15...........	3	192	34.8	96	17.5 loss
Check	Not sprayed	....	114.5	47.7	57.2	
Plot III ...	July 17, 31 .... Aug. 15, 28 .... Sept. 12	5	314.7	27	157.3	172 gain
Check.....	Not sprayed	....	190.5	46	95.2	
Plot IV ...	July 17, 31........ Aug. 15, 28........ Sept. 12	5	260.7	20.2	130	36.4 gain

TABLE V.—*Showing yield and profit for 30 acres sprayed over unsprayed.*

	Check plots.	Sprayed plots, five applications.
Average yield in bushe's for 30 acres	95	143
Total yield in bushels for 30 acres	2,850	4,290
Total value of crop for 30 acres at 40c per bushel	$1,140	$1,716.00
Total increase in value over check plots	....	$576.00
Average increase per acre	....	$19.20
Cost of spraying per acre	....	$3.70
Net gain per acre	....	$15.50

TABLE VI.—*Potato spraying experiment No. 3, Colfax, 1905, showing treatments and yields.*

Plots.	Treatment with Bordeaux mixture.		Yield of sample areas.		Yield per acre of marketable potatoes.	Percentage gain over check plots.
	Dates of application.	Number of applications.	Marketable potatoes.	Culls.		
			Lbs.	Lbs.	Bu.	
Check......	Not sprayed......	....	123.2	47	231	
Plot I......	June 29. .... July 12.	2	125.7	39	241	4.3 gain
Check......	Not sprayed... ..	....	103.2	43	198	
Plot II	June 29........... July 12, 27.	3	108.7	41	209	5.6 gain
Check.. ..	Not sprayed	....	101.1	42	193	
Plot III ...	June 29........... July 12, 27. Aug. 11.	4	131.6	42	252.6	30.8 gain
Check......	Not sprayed......	....	116.7	46	224	....
Plot IV....	June 29........... July 12, 27. Aug. 11, 25.	5	165.7	38	318	41 9 gain

TABLE VII.—*Giving yields and value for 30 acres sprayed over unsprayed.*

	Check plots.	Sprayed plots.
Average yield per acre in bushels	208	280
Total yield for 30 acres in bushels	6,240	8,400
Total value of crop for 30 acres at 40c per bushel..................	$2,496 00	$3,360.00
Gain over check plots for 30 acres.....	....	$864.00
Gain per acre	....	$28.66
Cost of spraying per acre....	....	$3.70
Net gain per acre	....	$24.96

TABLE VIII.—*Results from spraying the field of John Porter at Stevens Point, Portage County, 1906.*

PLOTS.	Number of applications	YIELD OF SAMPLE AREAS. Actual.	Calculated per acre.	Per cent. gain.
		Lbs.	Bu.	
Check	0	142	78	....
Plot I	6	144	79	1
Check	0	133.7	73	....
Plot II	6	164	90	22.5
Check	0	111	61	....
Plot III	6	146	80	31
Check	0	118	64	....
Plot IV	6	143	78	22
Check	0	113	62	....
Plot V	6	153	84	35
Check	0	81	44	....
Plot VI	6	141	77	75
Check	0	94	52	....
Plot VII	6	136	74	42
Check	0	97	53	....
Plot VIII	6	127	68	28
Check	0	90	50	....
Plot IX	6	147	80	60

Average yield of unsprayed areas in bushels per acre	59.6
Average yield of sprayed areas in bushels per acre	78.5
Average gain in bushels per acre	18.9
Average gain in per cent	32

TABLE IX.—*Results from spraying the field of R. C. Gibbs, Stockton, Portage County, 1906.*

PLOTS.	Number of applications.	YIELD OF SAMPLE AREAS. Actual.	Calculated per acre.	Per cent gain.
		Lbs.	Bu.	
Check	....	204	136	....
Plot I	6	241	160	18
Check	....	147	98	....
Plot II	6	172	114	16
Check	....	138	92	....
Plot III	6	173	115	25
Check	....	135	90	....
Plot IV	6	152	101	12
Check	....	64	42	....
Plot V	6	150	100	38
Check	....	133	88	....
Plot VI	6	220	146	65

Average yield of unsprayed areas in bushels per acre	90
Average yield of sprayed areas in bushels per acre	127
Average gain in bushels per acre	40
Average gain in per cent	40

TABLE X.—*Results from spraying on field of Kennedy Scott, Rio, Columbia County, 1906.*

Plots.	Number of applications	Yield of sample areas. Actual.	Yield of sample areas. Calculated per acre.	Per cent. gain.
		Lbs.	Bu.	
Check	0	120.5	100	.....
Plot I	5	253.5	211	110
Check	0	187.5	156	.....
Plot II	5	218	181	16
Check	0	241	201	.....
Plot III	5	248	206	2.4

Average yield of unsprayed areas in bushels per acre 152
Average yield of sprayed areas in bushels per acre 199
Average gain in bushels per acre 47
Average gain in per cent 30

TABLE XI.—*Results of spraying the field of H. C. Roberts, Rio, Columbia County, 1906.*

Plots.	Number of applications	Yield of sample areas. Actual.	Yield of sample areas. Calculated per acre.	Gain in per cent.
		Lbs.	Bu.	
Check	0	187	155	.....
Plot I	5	225	187	20.7
Check	0	168	140	.....
Plot II	5	199	165	18

Average yield of unsprayed areas in bushels per acre 147
Average yield of sprayed areas in bushels per acre 176
Average gain in bushels per acre 29
Average gain in per cent 19.5

ORCHARD FRUITS.

E. P. SANDSTEN.

The work of improving the native plum, which was started by the late Professor E. S. Goff, about twelve years ago, will be brought to conclusion at the end of another season. Out of a total of over 50,000 seedlings grown from the standard varieties, five or possibly six, superior varieties have been selected and are now being propagated and will soon be distributed for more extensive trials. One valuable fact has been brought out in the plum work at the Station, namely, that the native plum comes true, or nearly true, from seed. Also, that while the parent trees from which seed has been gathered were grown closely together, and must have cross pollinated freely, the seedling trees show remarkably little variation from one or the other parent. That is, few intermediate types have been obtained. All this would indicate that the native type and characteristics are very persistent, and while there is some difference between the existing varieties of native plums, it is far less than one would naturally expect. The difference can, in a large degree, be accounted for in the difference of soil and cultivation. We have noticed that a young tree will invariably bear larger and more highly colored fruit than an old tree, and that a seedling tree from the thicket will bear larger fruit when transplanted into the orchard. This fact should be borne in mind when new varieties are selected from a block of seedlings; otherwise, a hasty conclusion may be drawn.

The question will naturally be asked, "What is the future of the native plum in Wisconsin?" Our experience would in-

dicate that high culture and persistent selection will accomplish more for the native plum than direct crossing between the existing native varieties. The present status of the plum is due, with one or two exceptions, to selection and cultivation, and if we consider the marked improvement accomplished during the last 25 years, the outlook for the future is bright.

For the last three years attempts have been made to cross the native plum and the Japan and European varieties, and vice-versa; the result has been unsatisfactory. A number of crosses have been obtained, but in every instance, the seed failed to grow. The work will be continued, as there is no apparent reason why it should fail.

In the Experimental Apple Orchard are a number of seedlings, collected from various places in the state. Most of these have fruited this year, showing several very promising varieties. These will be propagated and sent out for trial. It is hoped that in another year sufficient data will be on hand to publish a list of new seedlings for the state.

SMALL FRUITS.

It has not been the policy of the Department to carry on testing and trial work with small fruits, since the selection of varieties is largely a matter of local adaptation, and the trials carried on at the Station would have only a local application or value. While this view may, in the main, be correct, it was felt that the Department should be in position to give general advice upon the questions relating to this subject, and to meet such demand, most of the leading varieties of gooseberries, currants, and strawberries have been planted. Records of these are kept, and valuable data will be available for future reference.

GREENHOUSE EXPERIMENTS FOR 1906.

JAMES G. MOORE.

In addition to the work carried on to determine the influence of excessive feeding of plants, a variety test and three experiments were given a place in the University greenhouses during the past year. Two of the experiments were new, the third having been carried on previously by the writer. These experiment and tests take into consideration a single phase in the culture of four of our most largely forced crops—radish, tomato, lettuce and cucumber. The work has not extended over a sufficiently long period to make a full report, but certain facts have been so clearly demonstrated that further work considering these points seems unnecessary.

THE RADISH.

The work carried on with the radish was merely a variety test, the object being to see which of the varieties tried would give best results under forcing-house conditions. Only a few sorts were tried this year, owing to the limited space, but further work along these lines will be carried on during the coming winter, when a full report of the work will be given.

TOMATOES.

The object of the experiment with the tomatoes was to determine the relative earliness of fruiting, and the amount of fruit produced by plants grown from cuttings and those grown from seed. Cuttings were taken on October 13, 1905, from Earliana plants growing in the field, and placed in the cutting bench.

On the same day seed of this variety was sown in flats. On October 26, both lots were placed in pots, where they remained until November 24, when 36 plants of each kind were set in the bench. The two kinds were planted side by side and treated exactly alike throughout the experiment. One pint of liquid manure was given to each plant on the following dates: January 22, February 5, 15, and 29, March 5, 19, and 31. No other fertilizer was used. One plant in each lot failed to produce fruit. As to the vigor of the plants, there was no appreciable difference when they had reached the fruiting stage.

On January 20, the first fruit was harvested from the plants grown from cuttings. The first fruit from the seedlings was picked just a month later, February 20. During this time the fruit produced by the cuttings amounted to 8 pounds. Fruit was harvested until May 1, when the plants were removed. At this time there was considerable green fruit on each lot of plants, the amount in both cases being practically the same. The plants were left on the bench until the market for house-forced tomatoes had been supplanted by the southern grown product.

During the time of harvesting, the cuttings produced 79 pounds of fruit, and the seedlings 71 pounds. It will be seen that the difference in the amount is equal to the amount produced by the cuttings before the first fruits were harvested from the seedlings. At the price obtained for the products (25c. per pound) this difference would amount to practically $22.00 for each crop from a house 20x100 feet.

This would seem to make the plants grown from cuttings much more valuable for forcing purposes. We must not, however, overlook another important factor. In order that the plants might have as nearly as possible the same treatment, both lots were set in the bench at the same time. There was a great difference in the size of the plants at that time, and the seedlings might easily have remained in pots four weeks longer without injury. This means that in the production of the two crops of tomatoes, at least a month in favor of the seedlings could be saved in the time during which the plants occupy the

bench. One familiar with the forcing of plants will readily see the importance of this item. With the present data there is very little to choose between plants grown from cuttings and seedlings for use in the forcing-house. We hope to be able to continue the experiment the coming year.

LETTUCE.

Sub-irrigation has been highly recommended by some as a means of supplying water to plants in the forcing-house, especially in the culture of lettuce. Tile or other means for distributing the water beneath the surface of the soil is provided. Some of the advantages claimed for this system are that it faciltates watering, requires less water, lessens chances of rot, and increases the yield. It is readily seen that the first advantage cannot be disputed, and the second is scarcely worth considering. It occurred to the writer that as large a crop ought to be produced by surface watering as by sub-irrigation, and that if the upper soil on the bench was of the right composition, and the watering properly done, no damage should result from rot. The object of the experiment was, therefore, an attempt to disprove or corroborate these views.

Two benches 4 x 30 feet were used in this experiment. A bench for sub-irrigation was provided with cement bottom and sides, and was made as nearly water tight as possible. Owing to the fact that the cement cracked around the edges, it was impossible to have it in perfect condition. Three rows of three inch tile were laid the entire length of the bench for the purpose of distributing water. The surface watered bench had ordinary board bottom and sides. Holes were bored in the bottom to permit better drainage.

Soil.—The soil placed in the two benches was the same in every respect, except that in the surface watered bench a layer of sod one inch thick was placed in the bottom to facilitate drainage. The bottom soil, four inches deep, was composed of equal parts of garden loam, compost, rotted sods and fairly sharp sand. In the remaining two inches of top soil, the compost was left out, in order that there might be very little or-

ganic matter at the surface, as the rot fungus is induced by decaying organic material.

The variety of lettuce chosen was Grand Rapids Forcing. Seed for the first crop was sown on October 6. The young plants were transplanted to flats October 25, and set in a bench 6 x 6 inches November 22, both benches having been thoroughly watered previous to planting. On December 5, the surface watered bench was lightly syringed to induce soil capillarity. At that time there was plenty of moisture in the soil, but the roots had not penetrated deeply enough to reach the supply, and the soil was so loose that there was very little moisture near the surface. On December 15, the bench was thoroughly watered. The sub-irrigated bench was not watered until December 26, and on the same day the other bench was cultivated for the purpose of destroying a mold which had appeared on the surface of the soil. Both benches were again watered on January 6. It will be seen that only ten days elapsed between the second and third waterings of the sub-irrigated bench. This is accounted for in three ways: First, some of the water escaped, due to the cracks in the cement bottom; second, the evaporation was greater in the sub-irrigated than in the surface watered bench, due to the fact that the plants on the former failed to cover the surface; third, the plants were making their most vigorous growth during this time, and therefore, required a great deal of water.

Yield.—The first plants were harvested January 15, at which time the entire surface watered bench was ready for market. The plants were very even, and large enough that tooth picking or bunching was not necessary. The sub-irrigated bench was very uneven; some of the plants were large, while with the greater number, tooth-picking was necessary. The crop was harvested at intervals extending from January 15, to 31, a like number of plants being harvested from each bench at the same time. All injured leaves were picked off and the plants weighed. The sub-irrigated bench produced 50 pounds, 8.5 ounces of salable product, and the surface-watered, 70 pounds, 13.25 ounces, which leaves a difference of 20 pounds, 4.75 ounces in favor of surface watering.

The second crop was grown under the same conditions, except that a fertilizer, composed of ¾ pounds nitrate of soda and 1 pound of bone meal, was applied to each 100 square feet of bench area, and the plants were set 8 x 8 inches instead of 6 x 6 inches. The benches were planted February 5, and were watered as follows: Surface-watered, February 3, 17, March 6, and 22. Sub-irrigated, February 3, March 6, 22, and April 4. The watering on April 4 was merely to keep the plants from wilting during the period of harvesting.

The first plants were harvested April 2, and the last were taken off April 7. The size of the plants was similar to that of the first crop; those of the surface-watered bench were large and more even, the sub-irrigated, very uneven. It was necessary to toothpick nearly all the latter, while practically all of those from the surface-watered bench were large enough without. The difference in the yield was even greater than in the first crop. The sub-irrigated bench produced 65 pounds, 6.75 ounces, the surface-watered, 104 pounds, 7.5 ounces, a difference of 39 pounds. While this is a large difference on a bench 4x30 feet, it does not signify all the advantage in favor of the surface-watered, as the demand for that produced by surface-watering was very great, and the quality of the crop superior to that of the sub-irrigated bench.

Watering.—Water was given only when the plants seemed to demand it. At such times a liberal supply was given, the benches being thoroughly wet down. On the surface-watered bench, when the plants had covered the surface, great care was exercised in applying water. The hose was run between the rows, so that no water came in contact with the leaves exposed to the sun-light. Due to this precaution there were no bad results from either rot, or tip-burn. The number of injured leaves was slightly greater on the surface-watered bench, but not proportionately greater than on the other bench.

In summing up this year's trials, it will be seen that in producing two crops, the surface-watered bench yielded nearly 60 pounds more lettuce than did the sub-irrigated bench. This would give a difference of approximately 600 pounds for a

house 20x100 feet. If the same ratio held good with a third crop (this being the usual number produced during the season) the total gain in favor of the surface-watered bench would be 900 pounds. If, on the other hand, the lettuce was sold by the dozen (as happened in this case) the results from the surface-watered bench would be nearly twice as much as from the sub-irrigated, due to the fact that two heads would have to be sold for the same price as that received for one head from the surface-watered bench. This might be remedied somewhat by reducing the number of crops, giving a longer period for that produced by sub-irrigation.

After obtaining these results, we are more thoroughly convinced that, with proper care, as large crops can be produced where surface-watering is practiced as where sub-irrigation is employed, and that the added precaution necessary is more than off-set by the difficulties and cost encountered in putting in a system of sub-irrigation.

As to the control of the rot, more data and trials with varieties of the Boston Market type are desirable before making any comparative statements as to the value of the two methods of applying water.

Cucumbers.—The work with cucumbers was to determine the value of superheated soil, or bottom heat, in the forcing of this vegetable. The work has been carried on for two seasons, and will be continued during the coming winter. We hope to be able to give a detailed account of the experiment at a later date.

HORTICULTURAL WORK AT NORTHERN SUB-STATIONS.

E. P. SANDSTEN AND E. J. DELWICHE.

The first year's work in northern Wisconsin has necessarily been more or less preliminary. The following lines of investigations were started last spring:—

First, to study the commercial side of potato culture on sandy soils with special reference to rotation of clover and potatoes, to marketing, to harvesting, and the prevention of potato blight and scab.

Second, to study the possibilities of commercial strawberry growing in northern Wisconsin, with special reference to the large markets.

Third, to study the possibilities for fruit growing on the Bayfield Peninsula, and at other points in the Lake Superior region.

POTATO INVESTIGATION.

The soil in a large section of northern Wisconsin is composed of a sandy loam, which, by proper handling, is admirably adapted to the growing of potatoes. This particular farm crop, while grown to some extent, has not received the attention it deserves from the farmers. The experiments were carried on at the sub-station at Iron River. The land had been in potatoes for several years, with the exception of one half acre, which was in clover. No fertilizer of any kind had been applied to the land for several years. The land was plowed early in the spring and treated in the following manner:—

Plot I. One acre was given a dressing of 10 loads of well decomposed barn-yard manure.

Plot II. One acre was given a dressing of 200 pounds of nitrate of soda, 200 pounds of potash, and 300 pounds of desiccated bone. These fertilizers were applied in two installments, July 2 and July 19.

Plot III. One half an acre; no fertilizer of any kind was applied.

Plot IV. One half acre was left without any fertilizer, but a heavy crop of green clover was turned under. The respective yields of these plots are given in the table below.

TABLE I.—*Yields of potatoes from the use of commercial fertilizers, barn-yard manure and clover sod.*

Plots.	Fertilizer.	Marketable potatoes per acre.		Small potatoes per acre.		Total yield per acre.		Per cent. of marketable potatoes per acre.	Per cent. of small potatoes per acre.	Increase of yield over check plot.		Increase of yield over check plot in per cent.
		Bu.	Lbs.	Bu.	Lbs.	Bu.	Lbs.			Bu.	Lbs.	
I.	Barn-yard manure, 10 tons	183	27	13	58	197	25	92.9	7.1	22	34	13.7
II.	Nitrate of soda 200 lbs.; sulphate of potash 200 lbs.; desiccated bone 300 lbs......	182	51	9	32	193	23	95.1	4.9	17	32	10
III.	Check, no fertilizer.......	167	45	7	6	174	51	93.7	6.3	......	..	....
IV.	Green clover, plowed under..........	239	30	2	10	241	40	99.1	0.9	66	49	37.2

The results from one year's work show conclusively the value of clover in rotation with potatoes. While a gain of 66 bushels per acre from the clover over the check is a relatively large one, the gain would have been considerably larger if the weather conditions during July had been more favorable. Few farmers use clover in rotation, and it is very seldom that a crop of green clover is plowed under to be followed by potatoes. Ordinarily clover stubble is turned under in the fall and seeded to grain, which is followed by potatoes. The increase in yield

for one year would more than pay for the hay crop; besides, the soil is made richer and put in better condition for future crops.

Clover is a natural crop in northern Wisconsin on almost all kinds of land. This is due to the heavy snow fall, cool summers, and relatively high humidity when compared with southern Wisconsin. The farmer should not be slow in making use of this natural growth of clover to improve his land and increase the yield of his farm crops.

STRAWBERRY GROWING IN NORTHERN WISCONSIN.

The possibilities for commercial strawberry growing in northern Wisconsin are, at the present, not realized by most people. The soil and climate are well suited for the production of fruits of high quality. Another advantage enjoyed by this section is the time of harvest, which is from two to three weeks later than in the southern part of the state. The harvest occurs at a time when there is no other fruit on the market and hence does not enter into competition with any other section of the country. The local market conditions are also unexcelled. There is a large population in the mining districts of Minnesota, Wisconsin, and Michigan, besides the cities of Duluth, Superior, and Ashland. These markets have not in the past been adequately supplied with small fruits and there are great opportunities for enterprising men to engage in commercial small fruit growing in northern Wisconsin.

To demonstrate the profitableness of commercial strawberry growing in northern Wisconsin, it was planned to plant one acre on the sandy soil at the Iron River Sub-Station and to manage the plantation in the same way that the average grower does. Due to the poor condition in which the plants arrived, which was caused by the delay in transit, the planting was abandoned and it was then too late to procure new plants. The planting was deferred for another year.

THE POSSIBILITIES FOR FRUIT GROWING IN LAKE SUPERIOR REGION.

In looking over the general horticultural possibilities of northern Wisconsin, the writer was greatly impressed with the apparent favorable conditions for fruit growing on Bayfield Peninsula and on the higher lands contingent to Lake Superior. Bayfield Peninsula, due to its favorable location, will in the near future, produce apples and cherries sufficient to supply the immediate wants of the near-by markets. Orchard trees of the hardier kinds can undoubtedly be grown successfully. There is little or no danger from late and early frosts as the temperature is equalized by the influence of the lake, and the summers are sufficiently warm and long to mature the fruit. Cherry growing should prove a profitable industry on this peninsula, as the climate is very similar to that of the Green Bay Peninsula, and the soil is admirably adapted to this fruit. To encourage fruit growing in this region and study the adaptability of the various varieties, trial orchards were established at the following points:

Ten acres of apples, plums, and cherries were planted two miles south of Bayfield on the farm of John Walters, adjoining the State Fish Hatchery. Five acres of apples, plums, and cherries were planted on the Madeline Island at the Old Mission on land belonging to E. P. Salmon, and six acres on the Douglas County Poor Farm at Superior. These orchards were planted late in May and made good progress during the season. The orchard at Superior is on heavy red clay but underdrained with tile. Only the very hardy varieties were planted at Superior, since the soil conditions are less favorable and the location of the orchard is not so good as at the two other places. It is not the object in these plantings to study the possibilities of commercial orchards in this section of the state, but rather to demonstrate that the larger fruits can be grown; also to test varieties as to their adaptability to the soil and climate of this section.

REPORT OF STATE NURSERY INSPECTION.

JAMES G. MOORE.

Each year adds to the recognized value of nursery inspection. Up to the present time, dangerously injurious insects and plant diseases have been kept at a minimum in Wisconsin. This is undoubtedly due to the fact that the majority of trees and shrubs planted in this state are purchased from nurseries which are inspected annually. Nurserymen are coming to recognize more fully the value of nursery inspection, and in some instances, even where their trade is wholly within the state (and inspection not required by law) they ask for it as a safeguard to the best interests of themselves and their patrons.

There are some phases of nursery inspection in the state which need attention. Probably the most important of these is the fact that only about one-half of the Wisconsin nurseries are inspected. This condition exists because the law requires only those firms shipping stock out of the state to have their premises inspected, and some nurserymen do not realize the advantages to be derived from inspection. Some of these firms have been doing business for a number of years. They grow part of their stock, and ship in a much larger per cent of what they sell. Left-over stock is lined out to be disposed of the following year, and thus becomes a source of infestation. The most serious of nursery troubles found here come from imported stock. A good example of this is the San José Scale. Every time it has been found in this state its appearance has been traced directly to stock brought from other states. It is readily

seen, then, that nurseries not inspected are likely to be infested with injurious insects or diseases. It cannot be denied that our inspection law is to protect fully those who are planting trees and shrubs in this state, inspection must be made compulsory to those selling stock in the state only, as well as to those who sell in other states.

Another phase of the work which needs attention is the traffic between inspected and uninspected nurseries. Such traffic should be made illegal. While the present law prevents shipping stock thus obtained out of the state, it does not protect the growers in the state who buy stock of inspected nurseries on the supposition that all stock sold by that nursery has been inspected. The fact that persons buy infested stock under such conditions not only works injury to the purchaser, but brings unwarranted censure upon the value of the nursery inspection.

The third unsatisfactory condition existing is the shipping of uninspected stock out of the state under certificates of inspection. It is undeniable that such is the case. Unscrupulous dealers obtain in one way or another inspection tags issued to some other nurseryman and use them to further, illegally, their own business.

There is one remedy which will remove all these troubles; viz, a law compelling all persons who grow and sell nursery stock within the state to have their premises inspected the same as nurserymen now carrying on an interstate business.

The inspection this year revealed the presence of San José Scale in two localities. In both instances the insect was found on imported stock. Fortunately, only a small block was infested in either instance, and such stock was immediately destroyed. A portion of the infested stock came from Howard C. Merrill, Geneva, N. Y. We were unable to determine from whom the remainder of the infested stock was purchased.

Some of the more injurious insects which are found on nursery stock in the state are as follows:—

OYSTER SHELL BARK LOUSE.

(*Mytilaspis pomorum.*)

This insect belongs to the same general class as the San José Scale. Unlike the latter, it is probably in every orchard in the state. It thrives best on trees which are in a weakened condition. When it becomes numerous it seriously injures the trees, and ultimately causes death. A casual observer seldom sees the real insect, for soon after hatching it secretes a scaly covering, the peculiar form of which gives it the name of Oyster Shell Bark Louse.

Life history.—The insect passes the winter in the egg state, protected by the scale of the parent. In May or June the eggs hatch and the young emerge from beneath the scale. They move around for a short time in search of a suitable feeding place, which is usually on some tender twig. They then insert their thread-like beak and begin to suck the juices from the tree. As soon as feeding begins, the insect becomes larger, and at the same time secretes its protective scale. The female molts (sheds its skin) twice, and the male once. After the first molt the two sexes are very dissimilar. The male has antennae, eyes, legs, and wings, while the female has none. The female secretes much the larger scale, and at first completely fills it. As soon as she begins to lay eggs the body shrinks, and when the full number (15 to 100) are laid, the parent dies.

Remedies.—Probably the best remedies are those which are intended to destroy the young insects before the scale is secreted. At this period, whale oil soap, or kerosene emulsion (1 to 12), will destroy it. As this stage differs somewhat from year to year it will be necessary to observe the insect and act accordingly.

COTTONY MAPLE SCALE.

(*Pulvinaria innumerabilis, Rath.*)

This insect which has wrought such havoc to the soft maple during the past three years is rapidly disappearing. Some

localities which were badly infested last year are nearly free this season. Natural parasites are undoubtedly responsible for the rapid decrease in number of this pest.

WOOLY APHIS.

(*Schizoneura Lanigera.*)

Two forms of this insect infest trees. The "aerial" form, which attacks the trunk and limbs, does not inflict much damage. It is readily detected by the cottony appearance which it causes. On the other hand, the "root infesting" form is one of our serious insect pests. Infested trees usually appear sickly and have a deficiency of healthy foliage. If the roots are infested, they will be found covered with galls, caused by the insect. During the early part of the summer the wingless females bring forth living females which are also wingless. Toward fall a winged form appears, and, later, a brood of males. The winged females produce eggs which give rise to a new generation the following spring.

Remedies.—Whale oil soap or kerosene emulsion will destroy the "aerial" form. The "root infesting" form is harder to combat. Carbon bisulphide, placed in the soil in proximity to the roots, or fumigation of nursery stock with hydrocyanic acid gas before shipping, will destroy it.

APPLE APHIS.

(*Aphis Mali, Fab.*)

This insect is one which causes nurserymen a great deal of trouble. Its chief injury is in checking the growth of young trees. There are several other species of Aphis which work in connection with the Aphis Mali, but all possess about the same characteristics. This particular form passes the winter in the egg stage. The eggs are laid in the fall, and soon after the young buds burst in the spring, these eggs hatch. As the number of insects is less at this time, they are often overlooked, but they multiply very rapidly and later on give the curled ap-

pearance to the leaves which is so noticeable and so often seen in the nursery row. While the insect is not a difficult one to destroy, if spray mixtures can be gotten where it is, nevertheless, it has been found one of the most difficult ones which nurserymen have had to combat. This difficulty is often due to not beginning in time. Usually spraying is not resorted to until the lice have become so numerous that the leaves are curled, and it is impossible to reach the insect. A great deal of the difficulty could be overcome if the trees were watched and sprayed with whale-oil soap or kerosene emulsion as soon as the aphid emerges from the egg in the spring and before it has had time to cause the leaves to curl. If this is done, the comparatively few aphids which are present at the beginning of the season will be destroyed, and the destructive work of their more numerous progeny prevented.

COXCOMB GALL.

(*Colapha Ulmicola.*)

Considerable apprehension has been caused by the presence of numerous galls on the leaves of young elm trees. They are usually three-fourths to one inch long and about one-half inch high. The sides are wrinkled perpendicularly and the upper edge notched. In color they are a somewhat darker green than the leaves, and, on the side exposed to the sun, are tinged with red. Its peculiar form somewhat resembles a cock's comb, from which the gall derives its name. When they become old they dry up and are of a darker color. An examination of the under side of the leaf shows that they are open and are filled with insects resembling aphids, and a white flocculent material. The insect is a plant louse and has the same general characteristics of the aphis. They are very numerous some years, while during others but few galls are found. The chief injury is the unsightly appearance given to the trees by this insect. As yet, no successful remedy has been found for it.

STRAWBERRY ROOT LOUSE.

(*Aphis Forbesii, Forbs.*)

Another aphis which causes considerable trouble in the state is the Strawberry Root Louse. These insects are greenish lice, which work on the roots of the strawberry plant. They live upon the juices sucked from the plant, and thus weaken it materially, sometimes causing death. Their presence is often detected by the ants which feed upon the honey-dew secreted by the aphids. Undoubtedly the ants often aid in the distribution of the lice over a strawberry plantation. The adult aphid lays eggs in the fall on the petioles of the leaves. About the only remedy in old beds is to burn them over, the same as for leaf-roller. Plants for a new bed should be dipped in a decoction of tobacco, or fumigated with hydrocyanic acid gas

WHITE GRUB.

(*Lacnosterna Sp—?*)

Considerable damage by the common white grub has been reported throughout the state this year. This insect is the larvae of our common June beetle, of which there are several species. Plowing the ground in the fall, which exposes the larvae to the weather, and the use of carbon bisulphide, are probably the most efficient means of combating this insect.

DATANA MOTHS.

A number of our nursery trees are subject to the attacks of one of a number of closely related species of caterpillars, the immature form of Datana moths. Among the more common are the yellow-necked apple-tree caterpillar and walnut caterpillar. They feed in groups, and when disturbed elevate both the anterior and posterior ends, forming a sort of saddle. They mature in from five to six weeks, descend by night to the ground, burrow from two to four inches under the surface, and

change to naked brown pupa. The following July they emerge as moths, which lay eggs on the leaves and soon young caterpillars appear. Their habit of feeding together makes hand-picking possible. Arsenical poisons may also be used to destroy them.

IMPORTED WILLOW WEEVIL.

(*Cryptorhynchus lapatha, Linn.*)

This insect was found again this year in considerable numbers in Carolina and Golden-leaved poplar, brought in from eastern states. All infested stock was destroyed. While it is possible to catch the insect before it emerges from the tree, the only safe way seems to be to discontinue buying these trees in the East. Home grown stock seems to be free from its ravages.

Three plant diseases seem to be prevalent to such an extent as to merit attention.

CROWN GALL.

(*Dendrophagus globosus, Toumey.*)

It is very difficult to detect crown or root gall diseases during the summer months, except in severe cases. As its prevalence seems to be on the increase in this state, nurserymen should exercise more care in shipping stock, and purchasers should refuse stock which has galls on or just above the roots.

ANTHRACNOSE OF RASPBERRY.

(*Gloeosporium venetum, Speg.*)

The Anthracnose is a very common disease of the raspberry and does a great deal of damage. It affects the cane first, later appearing on the young roots and leaves. The spots are purple at first, but later acquire a whitish center. The disease weakens the plant, and, when badly infested, the fruit dries up before ripening. Cut out the badly diseased canes and spray with Bordeaux mixture. At least three applications should be

made; the first before the buds open, followed by another after the foliage is out, and a third after the fruit is harvested.

BLIGHT.

(*Bacillus amyloborus, Burrill.*)

Apple blight was again prevalent in certain localities this year. Cutting out is the only remedy, and is not satisfactory. Nurserymen are beginning to turn their attention toward blight resistant trees, and those varieties most susceptible to its ravages will soon be excluded from the nursery row. Already several nurserymen have discarded the Transcendent Crab, and Yellow Transparent is likely to follow for the same reason.

The following nurseries have been inspected and are entitled to certificates:—

McKay Nursery Co., Waterloo, Wis.
W. W. Brown & Co., Hartland.
White Elm Nursery, Watertown.
Great Northern Nursery Co., Baraboo.
William Toole, Baraboo.
Z. K. Jewett & Co, Sparta.
Geo. Hanchett & Son, Sparta.
A. D. Barnes, Waupaca.
Shiocton Nursery, Shiocton.
Hatch & Bingham, Sturgeon Bay.
Jos. Gerondale & Co., Sturgeon Bay.
Evergreen Nursery Co., Brussels.
Hawks Nursery Co., Wauwatosa.
Currie Bros., Wauwatosa.
Mt. Pleasant Nurseries, Corliss.
Geo. J. Kellogg & Sons, Janesville.
M. B. Downing, Milton.
Coe, Converse & Edwards Co, Ft. Atkinson.
A. F. Tamblingson & Sons, Ft. Atkinson.
W. H. Bright, Ft. Atkinson.
Dane County Nursery, Oregon.

Henry Lake Sons, Black River Falls.
Wisconsin Nurseries, Union Grove.
Phœnix Nursery Co., Delavan.
John A. Salzer Seed Co., La Crosse.
Cascade Nursery, Osceola.
Bonny View Nursery & Fruit Farm, Tomah.

EXPERIMENTS WITH GRAINS AND FORAGE PLANTS, 1906.

R. A. MOORE AND A. L. STONE.

The tests with grain and forage plants in 1906 were largely a continuation of the work of previous years, although many new varieties of grains from the United States Department of Agriculture and from various other sources were tested in the breeding plots for the first time.

The grains and forage plants that have been carried through a regular course in breeding are transferred to the comparative test plots to determine whether they have any special merit over the crops ordinarily grown. In many instances, where sufficient samples are secured, varieties of grains are first tried in the comparative test plots to determine whether these varieties have any special merit, and, if so, foundation stock is saved for future breeding plots. In comparative test plots the crops are grown under farm conditions, and the yields are such as can be secured by any intelligent farmer.

The land for the breeding plots is located near the College of Agriculture and the portion of the field not used for the breeding plots is devoted to the comparative test work. The remaining land needed for the comparative tests is located in the Agronomy field, Experiment Station farm, two miles west of the College grounds, and is uniform and of a similar character to the breeding plot field except that it is somewhat poorer in fertility on account of continuous cropping. (See Fig. 23). About five acres of land were devoted to comparative tests.

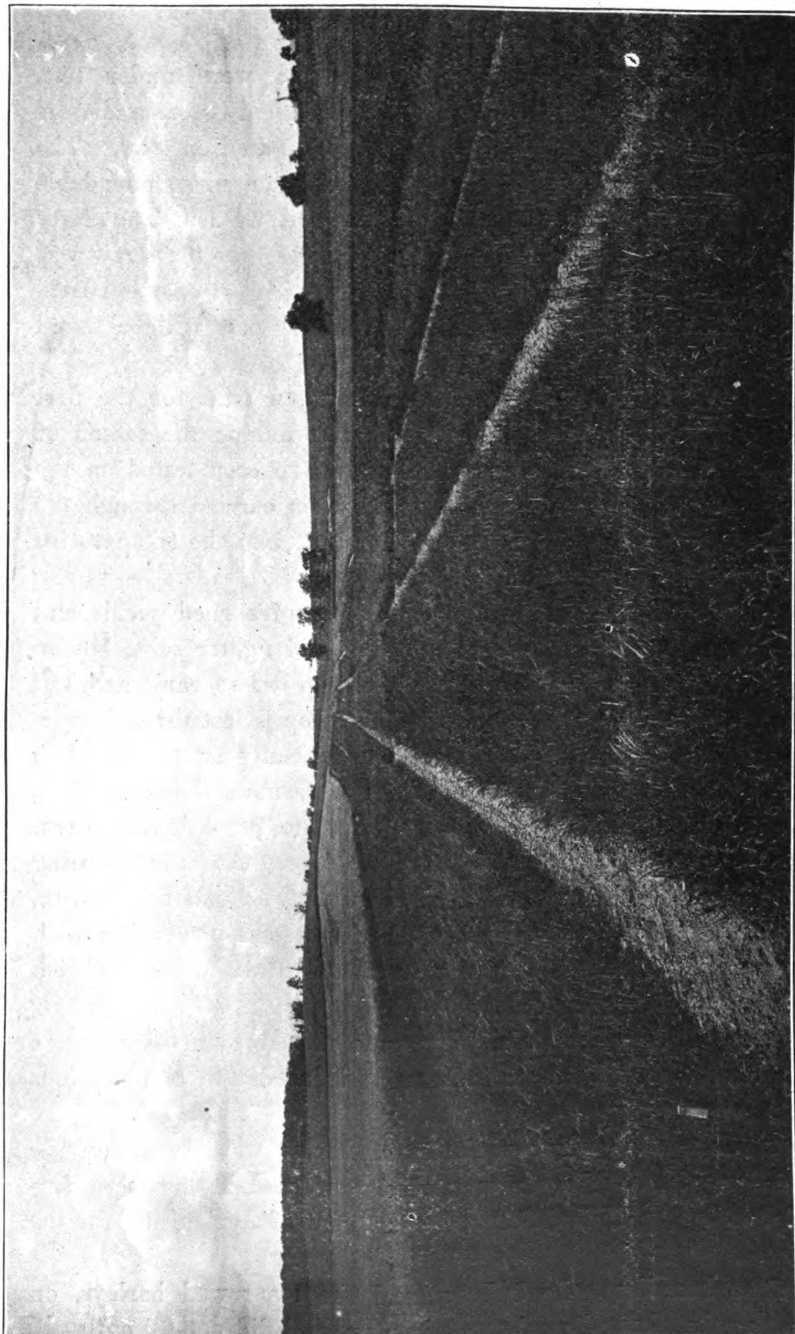

Fig. 23.—Tests for comparative yields of barley; sixty different varieties on trial.

A. CEREALS.

Oats.—Twenty-seven varieties of oats were under test. Twenty-two of these varieties have been tested before and were considered of sufficient value to again be placed on trial. The Sixty Day and the Kherson oats, which showed commendable qualities last season, again produced good yields. The Sixty Day oat showed its characteristic earliness, but the straw was weak and the plants lodged badly. All varieties of oats rusted this season. The Kherson and Sixty Day oats will be tested again next year.

Five new varieties of oats were put on trial for the first time and will be continued in the test during the season of 1907. No pedigree varieties of oats have been tested on the variety plots, but five varieties have been carried through the various steps in breeding and will be put into the comparative test plots in the season of 1907.

The Swedish Select oats continue to give good yields and are the most satisfactory on the high and lighter soils, but on the low, rich, prairie soils the straw grows so rank and tall that invariably a large portion of the crop is lost through lodging. Other varieties of oats lodge as badly as the Swedish Select, and it would be wiser for our farmers living in those localities where oats invariably lodge, to grow barley, corn, or some orop that is not so likely to lodge. An effort is being made to breed a short, stiff-strawed variety of oats for the low, rich soils, which may remedy the defect that now exists with practically all varieties of oats when grown on loose, rich ground.

The yields on the trial plots were greatly reduced by severe storms which lodged and otherwise injured the crop previous to harvesting.

Barley.—Sixty-four varieties of barley were tested on the Station plots. Many new varieties of seed barley were furnished by the United States Department of Agriculture for the test.

The beardless, the hulless, and the two-rowed barleys, on test again, showed weakness of straw, and did not fill out well.

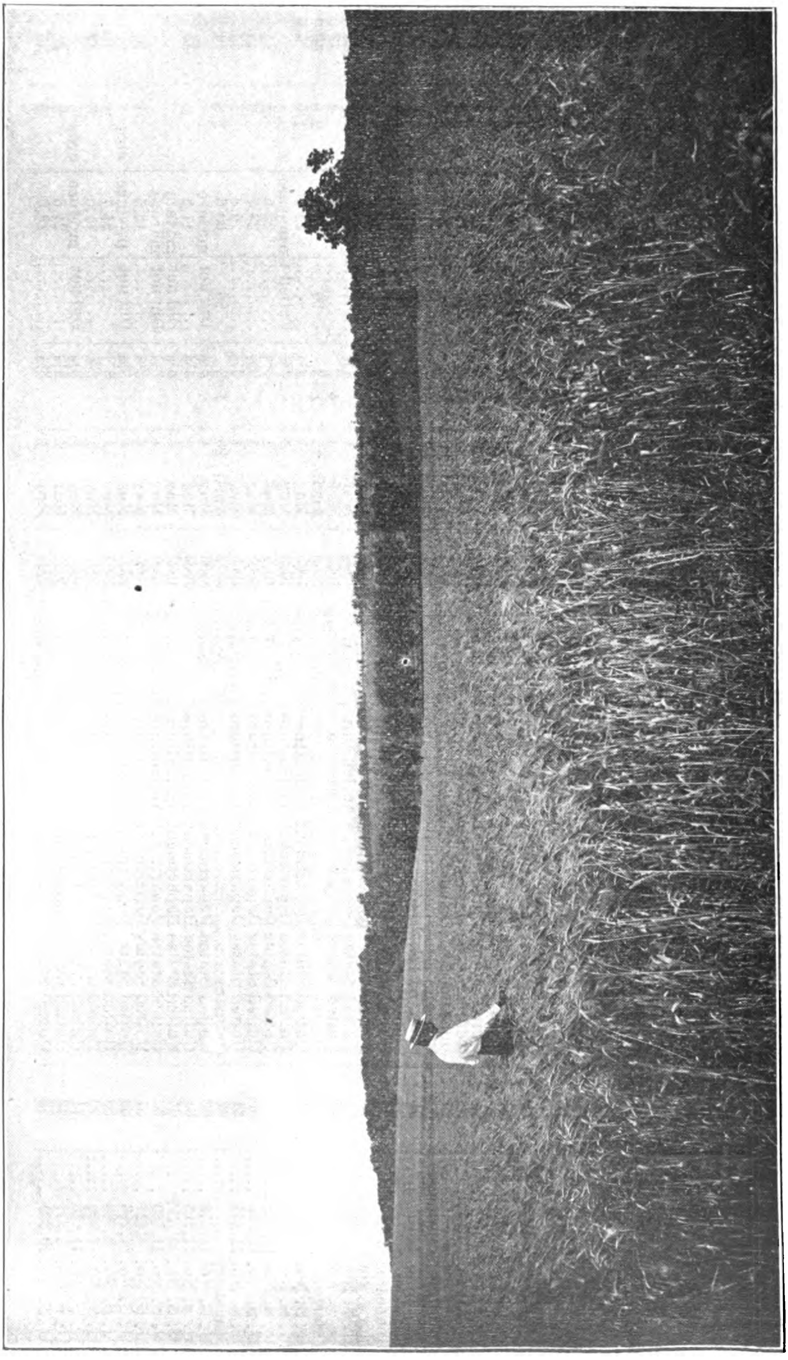

Fig. 24.—Oderbrucker barley, (Wisconsin No. 55), Experiment Station farm. Yield season of 1906, 60 bushels per acre.

TABLE I.—*Yield of grain and straw in variety test of cereals, 1906.*

NAME OF VARIETY.	Wisconsin number.	Origin of seed.	When received.	Date of sowing.	Seed per acre.	Days maturing.	YIELD PER ACRE. Grain (by wt).	YIELD PER ACRE. Straw.	Weight per measur'd bushel.
Barley.			Year.	1906.	Bu. Pk.		Bu.	Tons.	Lbs.
Silver King	3	John A. Salzer Seed Co., La Crosse	1900	April 25	1—2	98	61.3	2.6	45.5
Golden Queen	11	Minnesota Experiment Station	1899	April 25	1—2	99	44.4	2.4	45.0
Svanshals	16	United States Department of Agriculture	1901	April 25	1—2	98	58.3	2.2	44.5
French Chevelier	21	United States Department Agriculture No. 10,584	1904	April 25	1—2	110	27.2	2.2	43
Hannchen	22	United States Department Agriculture No. 10,585	1904	April 25	1—2	89	18.6	2.1	35
Princess	23	United States Department Agriculture No. 10,583	1904	April 25	1—2	99	22.9	2.9	44
Primus	24	United States Department Agriculture No. 10,586	1904	April 25	1—2	108	25.0	2.3	42.5
McEvans Hulless	28	Montana Experiment Station	1905	April 25	1—2	110	18.1	2.3	51.0
Black Hulless	29	Montana Experiment Station	1905	April 25	1—2	110	16.6	1.5	56.0
Hungarian Hulless	30	Montana Experiment Station	1905	April 25	1—2	....	7.7	....	48.0
Guy Male Hulless	31	Montana Experiment Station	1905	April 25	1—2	99	27.5	1.5	54.5
Franken	33	Wahl-Henius Institute, Chicago	1905	April 25	1—2	108	33.8	2.0	44.5
Tennessee Winter	36	United States Department Agriculture No. 11,193	1905	April 25	1—2	Did not	produce	heads	....
Norwegian	50	Norway	1905	May 4	1—2	....	17.6	.2	38.0
U. S. No. 11,621	52	United States Department Agriculture	1905	May 4	3⅛	....	19.1	.3	46
U. S. No. 11,192	54	United States Department Agriculture	1905	May 4	1—2	....	10.3	.6	42.0
Oderbrucker	55	Ontario, Canada	1899	April 25	1—2	98	60.1	2.6	46.0
U. S. No. 11,622	57	United States Department Agriculture	1905	May 4	3⅓	....	23.9	1.0	4.8
U. S. No. 11,623	58	United States Department Agriculture	1905	Mey 4	3⅓	Failed t	o mature	....	....
U. S. No. 11,620	59	United States Department Agriculture	1905	May 4	3⅛	....	22.5	.8	45
U. S. No. 11,264	60	United States Department Agriculture	1905	May 4	3⅛	....	23.7	.9	45
U. S. No. 11,265	61	United States Department Agriculture	1905	May 4	3⅛	....	6.6	.4	55
Manshury	62	Germany	1872	April 25	1—2	98	60.6	2.6	46
U. S. No. 11,658	63	United States Department Agriculture	1905	May 4	3⅓	Did not	mature	....	....
U. S. No. 11,716	64	United States Department Agriculture	1905	May 4	3⅛	....	17.8	.5	46
U. S. No. 11,717	65	United States Department Agriculture	1905	May 4	3⅛	Did not	mature	....	....
U. S. No. 11,780	66	United States Department Agriculture	1905	May 4	3⅛	Did not	mature	....	....
U. S. No. 7,427	67	United States Department Agriculture	1905	May 4	3⅛	....	13.5	.2	36
U. S. No. 7,796	68	United States Department Agriculture	1905	May 4	3⅛	Did not	produce	crop	....
U. S. No. 7,969	69	United States Department Agriculture	1905	May 4	3⅛	....	24.7	.4	46
U. S. No. 7,970	70	United States Department Agriculture	1905	May 4	3⅛	....	15.0	.3	47
U. S. No. 11,658	71	United States Department Agriculture	1905	May 4	3⅛	Did not	produce	crop	....
U. S. No. 9,877	72	United States Deparsment Agricultvre	1905	May 4	3⅛	....	21.8	.3	40
U. S. No. 10,360	73	United States Department Agriculture	1905	May 4	3⅛	....	13.0	.6	37

U. S. No. 10,361	74	United States Department Agriculture	1905	May 4	3⅛	....	10.8	.5	47
U. S. No. 10,363	75	United States Department Agriculture	1905	May 4	3[illegible]	....	16.1	.4	32
U. S. No. 10,862	76	United States Department Agriculture	1905	May 4	3⅓	....	4.6	.4	44
Odessa	77	Wahl-Henius Institute, Chicago	1906	May 19	1—2	....	19.4	.5	44
Royal	78	Wahl-Henius Institute, Chicago	1906	May 19	1—2	....	19.0	.6	44
Claude	79	Wahl-Henius Iustitute, Chicago	1906	May 19	1—2	....	17.2	.8	37
Mensury	80	Wahl-Henius Institute, Chicago	1906	May 19	1—2	....	35.7	1.0	42
Oats.									
Siberian	1	Canada Experiment Station	1899	April 25	2—2	103	30.0	3.1	20.0
Swedish Select	4	United States Department Agriculture, No. 2,788.	1899	April 25	2—2	105	39.0	2.8	20.5
Tobolsk	6	United States Department Agriculture, No. 2,800.	1899	April 25	2—2	108	37.2	3.7	....
Early Gothland	8	Minnesota Experiment Station No. 26	1900	April 25	2—2	108	6.8	2.2	20.0
Big 4	12	Salzer Seed Co. La Crosse, Wisconsin	1900	April 25	2—2	105	34.0	3.0	24.5
Lincoln	15	Minnesota Experiment Station No. 23	1900	April 25	2—2	108	21.3	3.0	23.5
White Bedford	17	Minnesota Experiment Station No. 85	1900	April 25	2—2	108	9.6	3.2	24.0
Sunshine	23	H. P. Crane, St. Charles, Illinois	1903	April 25	2—2	108	28.8	3.1	20.0
Silver Mine	25	Columbia County, Wisconsin	1900	April 25	2—2	101	36.4	2.6	19.0
White Belgian	28	Iowa Experiment Station	1900	April 25	2—2	101	30.8	2.8	19.5
Wisconsin Wonder	34	Jefferson County, Wisconsin	1900	April 25	2—2	101	43.1	2.7	24.2
American Banner	36	Fond du Lac, Wisconsin	1901	April 25	2—2	101	42.9	1.9	26.0
White Shonen	39	Fond du Lac, Wisconsin	1903	April 25	2—2	103	28 0	2.4	21.5
Belyak	40	United States Department Agriculture, No. 10,624.	1904	April 25	2—2	108	13.1	2.8	22.0
Sixty Day	41	United States Department Agriculture, No. 12,303.	1905	April 25	2—2	93	78.1	1.9	26.5
Danish	42	United States Department Agriculture, No. 12,877.	1905	April 25	2—2	101	51.1	3.0	24.5
Dun	43	United States Department Agriculture, No. 12,878.	1905	April 25	2—2	110	44.4	3.3	19.0
Sparrow-bill	44	United States Department Agriculture, No. 12,879.	1905	April 25	2—2	108	23.4	2.0	19.4
Canadian	45	United States Department Agriculture, No. 12,880.	1905	April 25	2—2	98	30.6	2.9	25.0
White Tartar	46	United States Department Agriculture, No. 12,881.	1905	April 25	2—2	110	21.7	2.5	22.0
White Russian	48	Ripon, Wisconsin	1905	April 25	2—2	110	23.8	2.5	20.0
Kherson	49	Nebraska Experiment Station	1906	April 25	2—2	95	60.0	2.7	27.0
Northrup King & Co.	50	Northrup King & Co., Minneapolis, Minnesota	1906	April 25	2—2	105	32.0	3.4	20.0
Twentieth Century	51	Dominion Experiment Farm, Ottawa, Canada	1906	April 25	2—2	105	27.6	2.8	23.0
Golden Fleece	52	Dominion Experiment Farm, Ottawa, Canada	1906	April 25	1—3⅛	105	35.0	2.9	23.0
Abbot	53	W. A. Toole, Baraboo, Wisconsin	1906	April 25	2—2	103	26.0	1.3	....
Rye.				1905.					
Minnesota No. 1	4	Minnesota Experiment Station	1902	Sept. 18	2—0	....	43.8	1.7	56.0
Minnesota No. 2	5	Minnesota Experiment Station	1902	Sept. 18	2—0	....	40.5	1.7	57.0
Minnesota No. 32	6	Minnesota Experiment Station	1902	Sept. 18	2—0	....	43.1	1.8	57.0
Ivanoff	7	United States Department Agriculture, No. 10,367.	1904	Sept. 18	2—0	....	28 6	1.8	54.0

The improved Oderbrucker (Wisconsin No. 55), and Manshury (Wisconsin No. 62), were the most satisfactory barleys grown. There were 1,300 bushels of improved Oderbrucker barley grown on the Station farm, all of which will be used for experimental purposes. (See Fig. 24).

Dr. David G. Fairchild of the United States Department of Agriculture has become interested in the Wisconsin barley work, and will coöperate with the Department of Agronomy in the breeding and testing of choice brewing barleys.

The coöperative work will not be confined to Wisconsin, but pure bred varieties of barley, developed in Wisconsin and elsewhere, will also be tested in other barley regions.

Two hundred and fifty members of the Wisconsin Experiment Association assisted in testing the Oderbrucker barley the past season. A summary of yields and other data is herewith given.

Number parties experimenting	250.0
Number parties reporting to date	98.0
Number counties from which reports have been received	35.0
Number sowing on fall plowed land	66.0
Number sowing on spring plowed land	30.0
Number sowing with drill	34.0
Number sowing with broadcast seeder	60.0
Number not reporting on the manner of seeding	4.0
Number cases in which barley remained erect	86.0
Number cases in which barley lodged	9.0
Number cases in which barley rusted badly	4.0
Number cases in which barley rusted slightly	16.0
Number cases in which barley did not rust	78.0
Number cases in which smut developed	25.0
Number cases in which no smut developed	35.0
Number cases in which smut developed slightly	33.0
Average yield in bushels per acre of Oderbrucker barley	40.0
Averiage yield in bushels per acre of best other varieties	34.4
Yield per acre of Oderbrucker barlev over other varieties on trial	5.6

Some interesting facts were discovered in examining the data presented in these reports.

The average yield per acre of Oderbrucker barley, on fall plowed land, was found to be 41.8 bushels; on spring plowed land, 35.9 bushels, a difference of 5.9 bushels in favor of fall plowing.

Where grain was sown with a drill, the average yield per acre was 41.1 bushels, and when sown with a seeder, 39.6 bushels.

Where a drill was used on fall plowing, the average yield

per acre was 43.3 bushels, and on spring plowing, 37.3 bushels.

Where the seeder was used on fall plowing, the average yield per acre as 41.2 bushels, and on spring plowing, 35 bushels.

Four cases were reported where the barley was sown on land not plowed, but worked up carefully with a disk harrow. In these cases the sowing was done with a seeder, and the average yield per acre was 22.2 bushels.

Row test of Wisconsin No. 7 corn.—Corn breeding, in accordance with the row system, was started at the University Hill Farm in the spring of 1905. Sixty rows, each planted from a single ear, were included in the test. The rows were numbered from 1 to 60, and data recorded concerning each. Four of these rows out-yielded the others, and the characteristics of the plants were such as to lead to the selection of seed from them for the breeding plot of 1906. The rows so selected were 1, 10, 12, and 52, and the best ten ears from each were planted in the 1906 breeding plot, making forty rows in all. The rows were three feet, eight inches apart each way, and there were one hundred eight hills in each row. The rows were exactly the same length as in the 1905 breeding plot. The corn from each row was divided into three grades: Seed corn, marketable corn, and nubbins. The amounts of each grade, total yield of each row, and each ten rows, as well as the comparison between them, are shown in the following table:—

TABLE II.—*Row tests of field corn.*

Ten rows planted in 1906 with seed selected from row No. 1, 1905.

Number of row.	Seed corn.	Marketable feeding corn.	Nubbins.	Total.
	Lbs.	Lbs.	Lbs.	Lbs.
1	27	88	21	136
2	54	130	20	204
3	36	131	30	197
4	69	116	21	206
5	39	106	17	162
6	57	139	14	210
7	62	115	20	197
8	31	111	20	162
9	56	109	16	181
10	24	112	17	153
Totals	455	1,157	196	1,808

Ten rows planted in 1906 with seed selected from row No. 10, 1905.

11	56	93	16	165
12	44	130	24	198
13	56	130	16	202
14	22	96	7	132
15	13	132	12	197
16	94	132	9	235
17	112	107	8	227
18	68	134	23	225
19	42	102	42	186
20	109	96	16	221
Totals	656	1,149	173	1,978

Ten rows planted in 1906 with seed selected from row No. 12, 1905.

21	43	156	12	211
22	44	134	15	193
23	45	154	10	209
24	63	118	10	191
25	41	156	14	211
26	37	148	3	188
27	52	163	7	222
28	41	145	6	192
29	26	154	1.8	181.8
30	55	107	4	166
Totals	447	1,435	82.8	1.964.8

Ten rows planted in 1906 with seed selected from row No. 52, 1905.

31	60	163	5	228
32	56	153	14	223
33	56	163	6	225
34	62	171	4	237
35	59	161	8	228
36	50	132	8	190
37	53	176	4.5	233.5
38	66	117	4	187
39	48	167	9.5	224.5
40	56	170	7	243
Totals	566	1,573	70.0	2,209

It is encouraging to note that the proportions and average yields of seed corn and marketable corn have been materially increased over those of a year ago.

The average yield per row of the various grades of corn in 1905 was: Seed corn, 22.6 pounds; marketable corn, 97 pounds, and nubbins 7.2 pounds. In 1906 the average yield per row was: Seed corn 53.1 pounds; marketable corn, 132.8 pounds, and nubbins 13 pounds. Allowing 80 pounds to the bushel, these ten-row plots gave yields in 1906 at the rate of 68.2, 74.6, 74.1 and 83.3 bushels, or an average yield per acre of seventy-five bushels.

Not all the increase is due to selection of seed, as the growing season in 1906 was more favorable and the plots were on better soil. It is noticeable, however, that the increase of seed corn is greater in proportion than that of the nubbins.

There are slight differences in the progeny of the different ears, with regard to the amounts of the various grades of corn, but the total yields per row in each ten row plot vary as little as is apt to be the case in any experiment of this kind.

The results for this year encourage the belief that constant selection of the best ears from the best rows of the breeding plot will materially increase the productiveness and improve the quality of our seed corn.

The best ten ears will be selected from the best row in each quarter of the breeding plot to plant a similar breeding plot the coming year.

An experiment was begun on the Station farm in the spring of 1905 to determine to what extent the bearing qualities of different stalks would be transmitted to their progeny. Upon two points in particular was information desired, namely whether constant selection of seed corn from stalks bearing a single large ear will tend to establish that quality, and to what extent this will affect the yield. The same information is desired concerning the selection of stalks bearing two ears.

With this idea in mind a plot was planted in the spring of 1906, in which there were sixteen rows. Eight of these were planted from the progeny of stalks which had borne a single

ear. The other eight were planted to seed from stalks which had borne two ears.

Yields and other data concerning the experiment will be found in the following table:—

TABLE III.—*Yield of corn from stalks bearing one ear compared with stalks bearing two ears.*

PLOT I.—*Seed selected from stalks bearing a single large ear.*			PLOT II.—*Seed selected from stalks bearing two good ears.*		
Row number.	Single ears.	Two ears.	Row number.	Single ears.	Two ears.
	Lbs.	Lbs.		Lbs	Lbs.
1	166	4	1	150	23
2	174	10	2	45	17
3	151	5	3	116	27
4	177	20	4	144	22
5	158	8	5	130	15
6	153	12	6	106	50
7	122	44	7	122	32
8	113	7	8	150	48
Totals...	1,214	110	Totals...	953	234

In Plot I, there are 1,214 pounds of single ears and 110 pounds of ears where two ears had grown on single stalks. In Plot II there are only 963 pounds of ears taken from stalks bearing a single ear, and 234 pounds of ears where two ears are grown on single stalks.

The selection for these two years has decreased the weight of single ears in one case and increased it in the other, and the same thing is true of the double ears. It is noticeable, however, that the total yield of corn is greater where the selection was made to increase the number of single ears than where it was to increase the number of double ears. The total yield in the former case is 1,324 pounds of corn from eight rows, each 396 feet long, and in the latter, 1,197 pounds. In almost every case where two ears were borne on a stalk, one or both of them, were small and poorly formed ears.

Corn breeding: Wisconsin No. 8—North Star Cross.—The experiment in crossing the Wisconsin No. 8 corn on other varieties was begun in 1905 and continued in 1906. Of the crosses made in 1905, that of the Wisconsin No. 8 on Toole's

North Star gave promise of best results. Accordingly, a plot of 2.8 acres was planted with seed selected from this cross, grown the season of 1905.

The field was fall plowed and was put into good tilth the following spring. The seed germinated well and the stand was almost perfect. The early portion of the growing season was cold and wet, which rendered the growth slow. The latter part of the season was excellent and the corn grew well. The corn was cultivated three times during the season, and the field kept free from weeds.

The stalks were heavily eared, and appearances indicate that the desired result has been obtained, and that the cross has increased the size of ear of the No. 8 and decreased the maturing period of the North Star.

The corn was ripe and cut September 26, 126 days after planting. The ripening period of the No 8 in 1905 was 120 days, and the North Star 133 days.

B. FORAGE CROPS.

Alfalfa.—The work in getting alfalfa established in Wisconsin has covered a period of many years. Ex-Governor Hoard has carried on tests with alfalfa through a series of years in Jefferson County that have been of immense value in demonstrating the importance and possibilities of this great plant.

Through the Wisconsin Experiment Association, with a large membership scattered widely over the state, the Station has been able to carry on coöperative tests with alfalfa under many varying conditions as to soil and climate. In many sections of the state alfalfa is yet in the experimental stage, and farmers should refrain from sowing large areas of alfalfa until they are certain that their land is suitable for the crop. The seed is expensive, and the crop is uncertain where conditions are unfavorable.

One or two acres should be grown for a few years as a test crop before seeding the farm extensively to alfalfa. Soil in-

oculation, as a preparation for growing alfalfa, is readily accomplished by mixing some alfalfa seed with clover seed when seeding down to clover. The alfalfa plants that grow will become bacteria distributors, and will aid materially in paving the way for future alfalfa crops on those fields where this practice is followed.

The alfalfa area is being rapidly widened and several thousand farmers are now growing the crop successfully.

Summer seeding of alfalfa.—In the summer of 1905, an experiment was started to test the value of summer seeding of alfalfa. The plot chosen for the experiment was one from which a crop of winter grain had been taken a short time before the alfalfa was sown.

The ground was plowed, harrowed twice, and a portion of the plot sown to alfalfa, without a nurse crop, July 14, 1905.

The remainder of the plot was sown on August 12, thirty days later. The fall was an exceedingly dry one, but, nevertheless, the alfalfa obtained a good start. The stand was good, although weeds were abundant and were clipped twice during the fall of 1905. On December 6, an observation showed the alfalfa in good condition for the winter, so far as growth was concerned. The weeds were more abundant in the plot sown July 14 than on that sown August 12, and the stand was a trifle less uniform.

An observation made on May 12, 1906, showed about 65 per cent of a stand on the plot sown on July 14, and only 30 per cent of a stand on the plot sown August 12. On June 1, the weeds and June grass were crowding the alfalfa badly, and on the 6th of the same month the plants began to turn yellow in spots. Rains had been frequent, so the yellow appearance could not be attributed to lack of moisture. Examination showed nodules in goodly numbers on the roots of the plants which had remained green, but none upon the roots of the plants which were turning yellow.

The plants were about fourteen inches tall, and appeared fairly well, except for the light color. Ten days later, June 11, the alfalfa on both plots began to bloom and was cut.

The yield on the July seeding was at the rate of 1.5 tons of field cured hay to the acre, part of which was weeds. The plots sown in August were so weedy and so mixed with June grass that no reliable record of the yield of alfalfa could be obtained.

A second cutting of one ton per acre was obtained from the plot seeded in July, but about fifty per cent of that was June grass and weeds. Both plots were plowed September 1 and later sown to winter grains.

This experiment has been continued in the spring of 1906 by sowing twelve acres of the Agronomy field at the Hill Farm, two miles west of Madison.

Beginning in early spring, the alfalfa was sown upon different dates and under varying conditions, as follows:—

On April 23 and 24, 8.94 acres were seeded to alfalfa at the rate of twenty pounds of seed to the acre, using barley as a nurse crop. The alfalfa grew rapidly and will go into winter with good covering for protection from frost.

A second plot of two and one-half acres was seeded to alfalfa, without a nurse crop May 11. Cultivation of the ground in this plot was begun as early in the spring as possible and was continued at regular intervals until the time of sowing the alfalfa, the object being to free the ground from weeds so far as possible. The alfalfa seed germinated well and the plants grew rapidly, but the weeds also appeared in great numbers and it was necessary to clip them twice, July 6 and August 24. The stand of alfalfa on October 10 was good.

A third plot of 9-16 of an acre was seeded June 1 on ground that had been cultivated whenever weeds became plentiful during the season. The cultivation was begun as soon as teams could get upon the land, and was kept up until the alfalfa seed was sown. As in the second field, the weeds grew rapidly and had to be clipped August 13. After this, the alfalfa came on nicelv, and at this writing, promises well.

The stand of alfalfa is better on the plots seeded April 23 with a nurse crop, than on either of the plots seeded later without a nurse crop.

Winter killing of clover and alfalfa.—The winter of 1906 was severe on clover and alfalfa, especially in the southern half of the state. To determine the extent of damage done, and the cause thereof, with other data of interest, letters of inquiry were sent to as many different counties as possible, to members of the Experiment Association. From the data received we are able to report the following:—

TABLE IV.—*Summary of reports on red clover.*

Number of members reporting	201
Number of counties from which reports were received	52
Number sowing clover as a mixture with grasses	152
Number sowing clover alone	49
Number of fields examined	354
Average number of living plants in each field on four square feet of surface	56
Average number of dead plants on four square feet of surface	18
Approximate number of acres in all fields inspected	6,192
Number reporting clover as badly winter killed	107
Number sowing with a nurse crop	198
Number sowing without a nurse crop	3
Maximum amount of clover seed sown per acre in pounds	23
Minimum amount of seed sown per acre in pounds	4
Average amount of clover seed sown per acre in pounds	10
Number pasturing clover first year	127
Number growing clover for seed	75
Average yield of seed per acre in bushels	4

Causes for winter killing: Ice on the ground through portion of the winter; sudden freezing and thawing in the spring; not enough snow; pastured too closely in the fall.

TABLE V.—*Summary of reports on alfalfa.*

Number of members reporting	118
Number of counties from which reports were received	39
Number sowing American alfalfa	66
Number sowing some other variety	52
Average number of living plants on four square feet	52
Average number of dead plants on four square feet	37
Number of fields entirely winter killed	15
Number of members sowing alfalfa with a nurse crop	85
Number using barley as a nurse crop	63
Average amount of seed sown per acre in pounds	20
Number sowing without a nurse crop	33
Total number of fields examined	201
Total number of acres of alfalfa inspected	365
Number reporting alfalfa as badly winter killed	54
Number who pastured alfalfa	7
Number growing alfalfa for seed	none.

Causes for winter killing: Sowing late in season; pasturing; cutting too late in season; nurse crop lodging; ice freezing over the ground; water standing on the field; freezing and thawing in the spring.

From the information secured from members of the Experiment Association, combined with the observations made at the Station and on farms in the vicinity of Madison, we conclude as follows:—

Clover and alfalfa were badly winter killed in the southern half of Wisconsin during the winter of 1906. In northern Wisconsin, the crop was protected by snow and suffered little.

Alfalfa proved to be as hardy as medium red clover where it was grown under like conditions.

The chief cause advanced by a majority of experimenters for the winter killing of clover and alfalfa was the frequent thawing and freezing in the early spring. Where alfalfa was grown on low, flat land it suffered much from the effects of the snow melting during warm days and filling depressions of the land with water, which froze during the night and smothered the alfalfa.

It was thought that alfalfa suffered from late fall cutting and by pasturing to a considerable extent.

Alfalfa seed is not as yet generally grown in Wisconsin. It will be necessary for the alfalfa plant to become acclimated before seed can be secured in paying quantities.

Clover is grown for seed extensively in Wisconsin, and an average of four bushels of seed per acre was secured by the members reporting.

C. MISCELLANEOUS EXPERIMENTS.

Plant breeding.—The plant breeding for 1906 has been continued in accordance with the system in vogue at this Station, and which has been described at length in the Twentieth Annual Report. The scope of the work was broadened somewhat by the introduction into the breeding plots of eighteen varieties of barley, seven of oats, one each of alfalfa and sweet clover, five of red clover and twenty-four of grasses.

Of those already in the breeding plots, five varieties of oats have gone completely through the breeding process and are to be transferred to the increase plots in 1907.

Ten varieties of winter wheat have been carried through the breeding test. Experimentation for eight years has shown our soils and climatic conditions to be unfavorable to the satisfactory production of winter wheat. The present season has been little, if any, worse than others, yet the winter wheats almost without exception rusted and lodged so badly as to prevent the proper filling of the grain. The comparative test plot

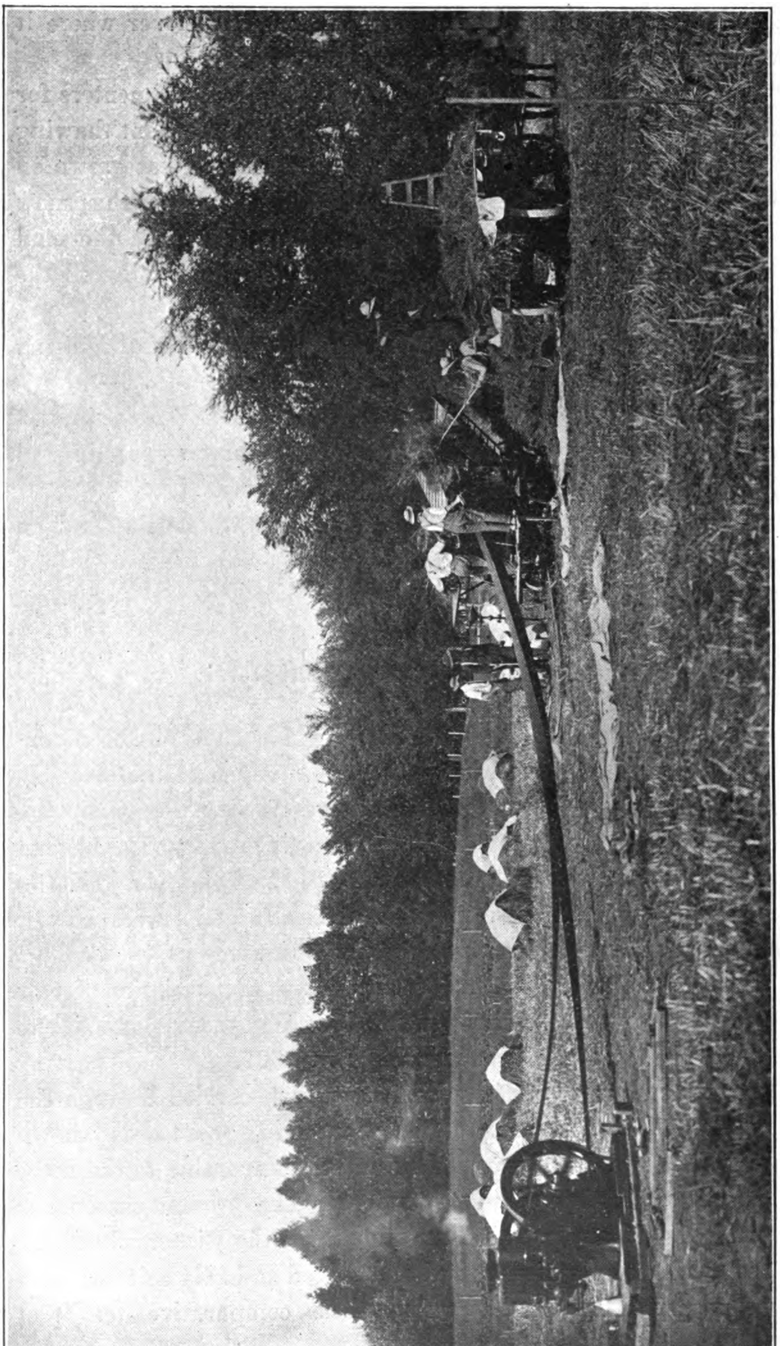

Fig. 25.—Plot thresher in operation.

work has been greatly facilitated by the purchase of a small thresher, expressly equipped for threshing and cleaning small quantities of grain. (See Fig. 25).

The pure-bred barleys which were transferred to the increase plots last spring have given good results. It will be understood that the grain sown on each of these increase plots is the progeny of a single grain, and complete and definite records have been kept concerning them. They are as nearly pure-bred as any process of breeding at present in use can make them.

Two varieties of barley showed slight variations as to stiffness of straw and maturing qualities in the different plots of the same grain. Two of the four plots of Golden Queen barley were much taller and more thrifty than the other two, although sown side by side. Slight variations which existed between the plants when breeding began became more prominent as breeding advanced

There was also a pronounced difference in the appearance of the grain on two of the plots of Silver King barley, which were sown side by side. On one plot the barley remained almost completely erect, and ripened four days earlier than that on the adjoining plot. The heads were of good length, but the straw of only medium height. On the other plot the grain was about two inches taller and partially lodged. As noted before, it was later in maturing.

There was practically no difference in the plots of Oderbrucker or of Manshury barley. Both of these varieties had been bred by selection for several years at this Station before the present system of breeding was begun, and have their characteristics firmly fixed. The grain on the best plot of each of these four varieties has been retained for sowing a larger plot the coming year and will be increased for dissemination as rapidly as possible.

In making the selection of the seed to be retained, especial value is given to stiffness of straw and early maturing qualities coupled with as great a yield as possible.

Peculiar weather conditions existed in the fall of 1905. The winter grains were sown about the middle of September and

from that time until the snow appeared so little moisture fell that some of the grain never appeared above ground. The two increase plots of winter rye and one of winter wheat germinated well, but did not get a good start because of the drouth. Not one of them survived the winter and the ground was plowed and used for other purposes.

Of the varieties in the comparative test plots this season, four of rye, five of oats, and five of barley are considered as worthy of further attention, and will be introduced into the breeding plots in the spring of 1907.

ERADICATION OF WILD MUSTARD.

R. A. MOORE AND A. L. STONE.

Wild mustard has become a well known pest and a great source of annoyance to the farmers of Wisconsin. Hundreds of square miles of good crop lands are a great mass of yellow blossoms during the flowering period of this obnoxious weed. The seed is disseminated in several ways.

Usually the soil becomes infected with mustard from manure which has been taken from barns where stock have been fed grain, hay, or straw in which there is a mixture of mustard seed, which, owing to its hard seed coat and oily nature, is hard to digest and passes through the animal with its vitality unimpaired.

The pest is sometimes introduced by farmers who send into other states for seeds which happen to be badly adulterated with mustard.

The seed is also distributed from field to field by birds.

Occasionally a farmer, through the mistake of an ignorant seedsman, receives his first supply of mustard seed instead of the desired rape or turnip seed, the similarity of the seeds readily offering a chance for mistake on the part of one not thoroughly familiar with them. The mustard seed is smaller and of a lighter color than rape or turnip seed. Where any doubt exists the seed should be sent to the Experiment Station or to a reliable seedsman for identification.

Unless the ground becomes too thickly seeded with mustard, the plants, when in bloom, are easily seen and can be pulled

before the seeds have matured. After the plants have been allowed to mature for a few years, the ground becomes so filled with seed as to make hand pulling a laborious task.

Fig. 26.—Mustard plant at the proper stage of growth for most effective spraying.

In the spring of 1906 the American Steel and Wire Company called the attention of the Department of Agronomy to a m thod of spraying mustard plants with a solution of iron sulphate. This company has large quantities of iron sulphate as a by-product in their treatment of iron and steel previous to its manufacture into a finished product. Upon corresponding with the company the managers willingly sent Dr. H. E. Horton, their chemist, to assist the Station to carry on experiments with iron sulphate.

Tests in Dane, Waukesha and Kenosha counties were made on farms that were badly infested with mustard. Owing to the delay experienced in getting a reliable sprayer, the plants in some of the fields were past that period of growth when the tissues of the plants are most susceptible to the action of the iron sulphate solution. The proper time for spraying to get best results is when the plants are in the fourth leaf. (See Fig. 26).

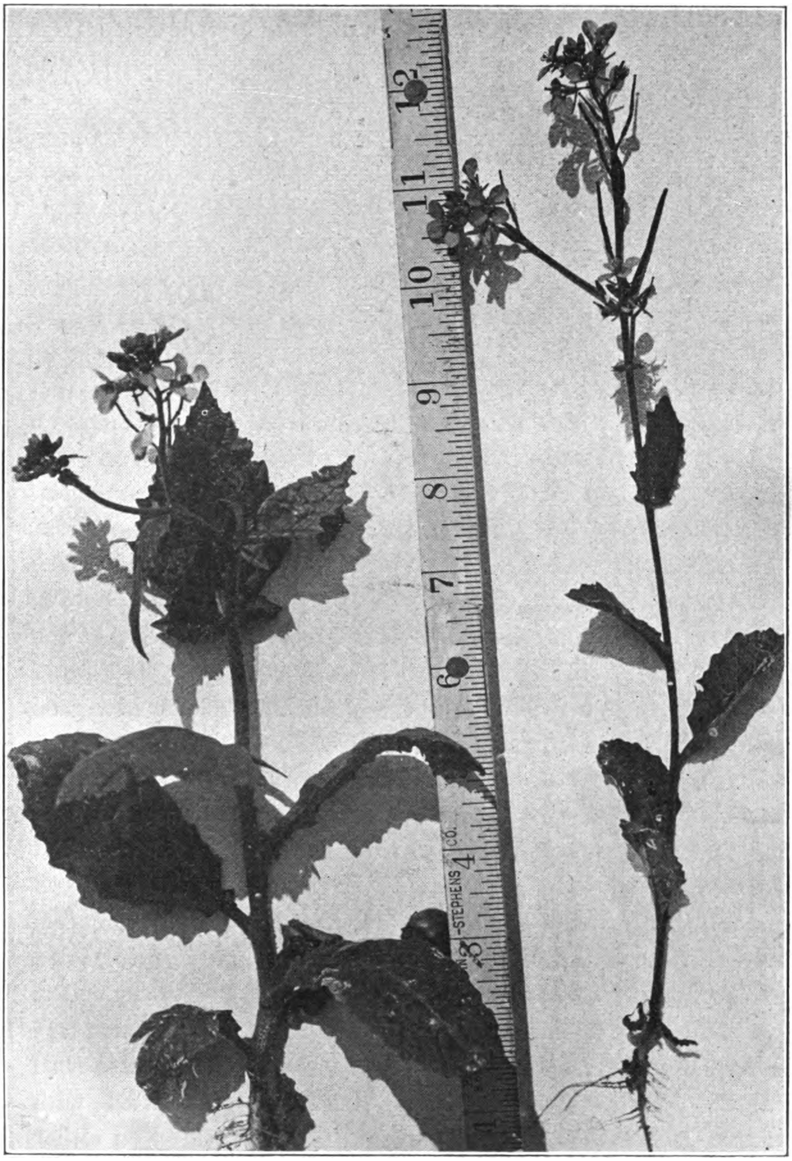

Fig. 27.—Plants that are in blossom can be exterminated if pods are not fully developed.

At that time the leaves spread out with their broad surface upward and are easily hit by the spray. Any time before the flowering period, the plants can be effectually eradicated from grain fields, if weather conditions are right, without injury to grains or new seeding of grasses. (See Fig. 27).

The first experiment was tried on the farm of Otto Toepfer, near Madison. The field in which the test was made had been rented for a series of years, and no attempt had been made to eradicate the mustard. The ground was so thickly covered with these plants that from 75 to 100 were found to the square foot and several counts gave an average of 50 plants to the square foot.

Making the solution.—The solution is made (see Fig. 28), by emptying a hundred pound sack of iron sulphate into an ordinary 52 gallon cask, (kerosene or vinegar barrels are gauged for approximately that amount) and then stirring until the sulphate goes into solution. Iron sulphate is in a granular form similar to that of salt or sugar and goes into solution readily. When stirred vigorously 7 to 10 minutes, the sulphate is dissolved. Made in the proportions given, we found that the mixture was practically a 20 per cent solution, the proper strength, although some German experimenters have had good results by using a 15 per cent solution.

The first tests were made with an American sprayer but this did not do satisfactory work; the nozzles of the sprayer would clog, and, as a consequence, little patches of mustard were left unsprayed.

A Platz sprayer, (see Fig. 29), ordered from Germany, arrived in time to finish the spraying work at the Toepfer farm in a satisfactory manner.

A strip through the field, 30 feet in width, was left unsprayed for comparison. Inspection of the field, June 18, showed that the portion of the field left unsprayed was filled with mustard plants in full bloom, while the general field on either side of the unsprayed strip was practically free. (See Fig. 30).

Fig. 28—**Making the iron sulphate solution preparatory to spraying; a 100-pound sack of sulphate makes sufficient solution to spray one acre.**

The Toepfer field was again inspected July 9, and careful counts showed that approximately 95 per cent of the mustard plants had been killed. The few remaining plants were only partially coverd with seed pods, and from their dwarfed nature seemed to have come forth after the field was sprayed.

Fig. 29.—Eradication of wild mustard from grain fields by the use of iron sulphate solution. Sprayer in operation.

An adjoining field without any planted crop had a heavy stand of mustard, cocklebur, rag weed, etc. The mustard had reached full bloom, and well developed pods filled with seed, hung thickly upon each plant. In spraying this field the solution was made more effective by adding 1½ per cent of sulphuric acid to the 20 per cent solution of iron sulphate. The field was sprayed June 12, and inspected June 18; all plants upon which fully developed pods had not formed were killed. The plants having large pods were scorched, but were not prevented from developing some seed. On account of the height of these plants, it was impossible to completely cover them with spray; consequently, that portion of the plant that was not touched with the spray was not injured, and seed pods continued to develop.

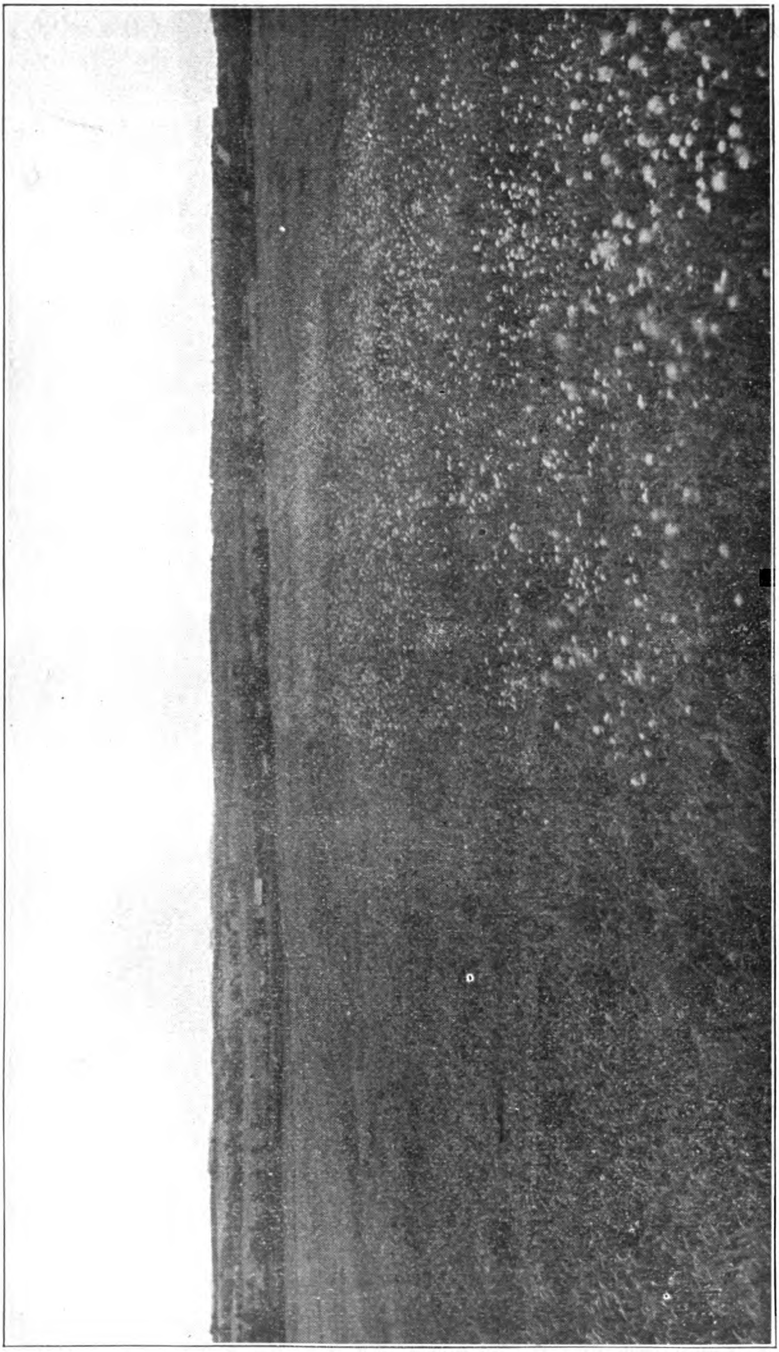

Fig. 30—View of grain field two weeks after spraying for the eradication of wild mustard. The strip through center not sprayed.

There seemed to be a hastening of the maturity of the seed where a portion of the plant had been struck by the spray. Seed collected from the partially sprayed plants readily germinated, showing that sufficient life remained in the plant to accomplish its mission of seed production.

Further tests were made at Mukwonago, in Waukesha County, and Kenosha, in Kenosha County. Two of these tests were fully as satisfactory as that made in the Toepfer field, but in one test on the farm of Mr. Isaac Blood, in Waukesha County, the results were not so satisfactory. The spraying was done in the same way it had been performed on the other fields, but a rain followed three hours after the spraying, and the strength of the solution was sufficiently neutralized to prevent the killing of all the mustard. An examination twenty-three days after spraying, showed that approximately 40 per cent of the plants developed seed to a greater or less extent.

One of the most successful tests made was on the Bain estate, Kenosha, in which the grain fields were badly infested with mustard, which, at the time of spraying, was in full bloom and many plants had well developed pods.

Intervening strips were left unsprayed so as to be able to readily detect the effectiveness of the work. This field was sprayed June 21 and 22. Inspections made July 14 showed that the treatment had been effective; only an occasional living mustard plant could be detected, while in the strips not sprayed there seemed to be as many mustard plants as there were grain plants. The grain did not seem to be injured in any way; in some instances the tips of the grain plants were scorched, but this did not seem to retard their growth. The demarkation of the sprayed and unsprayed strips was pronounced, not only by the absence of mustard plants within the sprayed strips, but by the absence of many other obnoxious weeds. Cocklebur, bind weed, rag weed, daisies, and several other weeds suffered severely from the effects of the spraying.

Canada thistles, which grew abundantly in the field, were badly scorched, which leads us to believe that by spraying at intervals for two successive years, it may be possible to at least

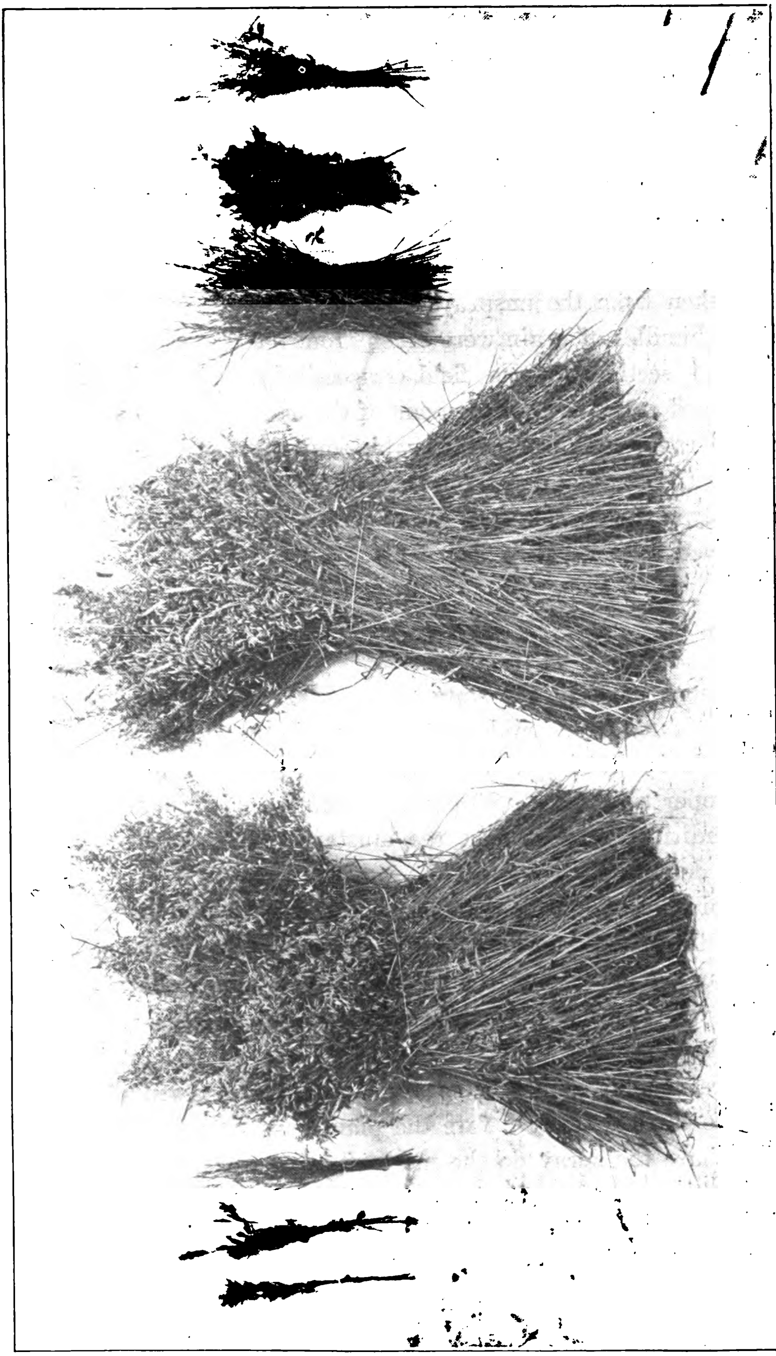

Fig. 31.—Eradication of wild mustard and other farm weeds from grain fields. Weeds and bundles of grain on left from the sprayed portion of the field; bundle and weeds on right from sprayed section.

check the growth of this obnoxious pest. Experiments will be carried on next year to determine what can be done in the way of the eradication of thistles from grain fields.

Previous to cutting the oats, samples of standing grain and weeds were taken from ten square feet of both the sprayed and the unsprayed plots. The weight of grain plants taken from the ten square feet of the sprayed plot was $2\frac{1}{2}$ pounds, which equaled the weight of the grain plants, plus the weight of the weeds taken from the unsprayed plots.

Three bundles of grain were taken from the sprayed and the unsprayed section of the field respectively. These bundles were opened and a separation made of the oats, mustard, cocklebur, and rag weed. A considerable quantity of weeds was found in the bundles from the unsprayed section of the field, while only a few weeds were found in the bundles taken from the sprayed section. (See Fig. 31.)

SUMMARY.

In various parts of the state, grain fields were found to be so contaminated with wild mustard that it was impossible to eradicate it by hand pulling. By spraying these grain fields at the proper time with a 20 per cent solution of iron sulphate when conditions were proper, the mustard plants were practically all destroyed.

The spraying should be done on a calm, bright day, after the dew has disappeared, as the work is more effective if the solution is put on in the warm sunlight. When rain follows the spraying within a few hours, the extermination of the mustard will not be complete.

The grain fields should be sprayed when the mustard plants are in the third leaf, or before the plants are in blossom, in order to have the spray do the most effective work. The day following the spraying, the tips of the blades of grain may be somewhat blackened, but no detrimental effects can be noticed, either to the crop or grasses seeded with it, two weeks after spraying.

Daisies, cocklebur, bind weed, rag weed, chickory, sheep sorrel, yellow dock, wild lettuce, and many other weeds were partially or wholly eradicated from the fields where tests were made for the extermination of mustard.

Iron sulphate can be purchased for about eleven dollars per ton in small quantities, and in bulk for considerably less. One hundred pounds of iron sulphate will make sufficient solution of the proper strength to spray approximately one acre. From twenty to twenty-five acres of land can be covered in a day, where the sprayer is kept in continual use.

The iron sulphate solution is not poisonous and can be readily handled without injury. White clothing coming in contact with it will be discolored, but not burned.

TREATING SEED GRAINS FOR THE PREVENTION OF SMUT.

R. A. MOORE AND A. L. STONE.

From 1898 to 1903 extensive tests were made by the Experiment Station to determine the loss experienced by Wisconsin farmers from oat smut and the most effective remedy to be used for its eradication. Members of the Wisconsin Experiment Association and many other farmers took an active part in these investigations, which were made in all grain growing counties, and in practically every township, until farmers were made acquainted with the smut disease affecting oats and its remedy. From the tests made in was found that no less than 20 per cent of the oats grown in the state was lost through smut. This great loss represented a money value of over four million dollars annually.

The oat smut remedy was so generally adopted that in 1904 the oats throughout the state, with few exceptions, were smut free, or nearly so. Owing to the contagious character of the disease and the rapidity with which it spreads, the greatest vigilance must be exercised by our farmers, or our fields will again be contaminated. From observations made this season, we find that many farmers are negligent and their oat crops are again becoming smutted. The remedy is so simple, cheap, and effective that there is no excuse for the Wisconsin farmers allowing the oat smut to take possession of their fields. All seed oats for next year's sowing, unless known positively to be smut free, should be treated for ten minutes in a formaldehyde solu-

tion. Bulletins, giving full description of the treatment of seed oats for the eradication of smut, will be sent free upon application to this Station.

Fig. 32.—Different stages of the loose smut of barley from early appearance until blown from the stem.

Barley smut.—During the crusade against oat smut in the state, it was apparent that barley was contaminated with smut to a less degree than oats. The smut increased from year to year, and experiments were started at the Station to put it under control. The treatment of barley by submerging it in a solution made by pouring one pint of formaldehyde into a cask containing twenty gallons of water was not successful. Some smut remained in the crop which the most careful treatment could not eradicate. (See Fig. 32). Further tests made

on the barley taken from the crop, the seed of which had been treated, showed that very little benefit, if any, resulted from the formaldehyde treatment.

Similar tests to those made by the Station were made by the members of the Experiment Association with the same results. Many farmers throughout the state complained that after the first year's treatment of barley, subsequent treatments of seed did not appear to lessen the smut. There are two varieties of smut which affect barley, known as closed and loose smut. The closed smut can be eradicated by the formaldehyde method of treatment, but the loose smut will not yield to this treatment. An experiment was started at the Station in the spring of 1906 in which several methods of treatment were used, with the hope of finding some treatment that would be effective for both varieties of barley smut.

For these tests the Hannchen barley was used. In 1904 this barley contained 12.1 per cent of smut. In the spring of 1905 the seed was treated with formaldehyde but the resulting crop contained 7 per cent of smut.

The accompanying diagram will give an idea of the plan of the field plots on which the treated grain was sown:

The various methods of treatment employed were as follows:

First.—The treatment which proved successful in eradicating the smut is familiarly known as the "Jensen" Hot Water treatment. (This method of treatment was discovered by Professor C. F. Jensen, of Denmark, in 1888, and further tested and modified by W. F. Swingle, United States Department of Agriculture, in 1898.) The treatment used at the Wisconsin Station was a modification of the Swingle method. The barley was placed in gunny sacks and submerged for twelve hours in cold water for the purpose of softening the hull and berry; it was then pulled from the cask and left one hour to drain. The sacks of barley were then submerged in a cask containing hot water, held at a constant temperature of 130° F. for five, ten, and twenty minutes respectively. By having boiling water in a kettle or tank near at hand, some can be added to that in the cask in which the barley is submerged, as the temperature will

a	Seed soaked in wa hours. Submerged in wa 130° F. for 20 minu	Control.	Seed not soaked previous to treatment. Submerged for 12 hours in a solution made by using one pint of formaldehyd in 20 gallons of water.
b	Seed soaked in wa hours. Submerged in wa 130° F. for 10 minu	Control.	Seed not soaked previous to treatment. Submerged for 6 hours in a solution made by using one pint of formaldehyd in 20 gallons of water.
c	Seed soaked in wa hours. Submerged in wa 130° F. for 5 minute	Control.	Seed not soaked previous to treatment. Submerged for 10 minutes in a solution made by using one pint of formaldehyd in 20 gallons of water.

be somewhat lowered after the sack of barley is put in. The sack of barley should be put into a barrel of water, the temperature of which is slightly lower than 130° F., in order to warm before being submerged in the water which is kept constantly at 130° F.

Seed barley should be sown on the same, or not later than the day following treatment; otherwise it will sprout and difficulty will be experienced in getting it to run through the seeder or drill.

Second.—The corrosive sublimate, or bichloride of mercury method consisted of one part corrosive sublimate to one thousand parts of water, and the seed barley was submerged in it for six hours, one hour and ten minutes respectively.

Third.—The formaldehyde method was that in which the seed barley, after having been left in cold water for twelve hours, was submerged in a solution made by using one pint of formaldehyde to twenty gallons of water. The seed barley was submerged in this solution for twelve hours, six hours and ten minutes, respectively.

Another test was made without soaking the seed barley, but submerging it in the solution for the same periods of time as for the previous experiment.

The control plots, on which the grain had been sown without treatment of any kind, were placed between the others to give a good comparison as to the effects of the various treatments.

SUMMARY.

(1) Two varieties of smut affect barley, known as closed and loose smut. The closed smut is eradicated by the formaldehyde method of seed treatment, but the loose smut is not.

(2) From extensive tests made by the Experiment Station, barley is found to be affected by smut to the extent of not less than 7 per cent, which means a money loss of at least one-half million dollars annually to the farmers of the state.

(3) All this loss can be saved by the hot water treatment of seed immediately preceding seeding.

(4) No danger of destruction of seed will be experienced if water is not allowed to go above 130° F., or the grain submerged longer than ten minutes; the seed will germinate much more readily, which is an advantage in a dry season.

(5) No farmer should be guilty of losing 7 per cent of his crop through smut, after learning of a simple, effective remedy for the treatment of the seed grain.

(6) Oat smut spores are destroyed by the hot water treatment without the necessity of previous soaking in cold water.

CROP WORK AT THE NORTHERN SUB-STATION FARMS.

R. A. MOORE AND E. J. DELWICHE.

The farm crops work started at the northern sub-stations for the season of 1906 was mainly to test and acclimate varieties of grains and forage plants that had proved their worth in southern and central Wisconsin. Pure-bred varieties of barley, oats, and corn were grown with a view of disseminating those crops that showed special merit.

The difference in soil conditions on the sub-station farms was a factor that caused a wide variation in the nature of the growth of the various cereal crops. The soil at the Ashland and Superior farms is a heavy clay, while that of the Iron River farm is a sandy loam. The land at the Iron River Station was in fit condition for the sowing of crops April 16, ten days before the ground at either of the other stations was in working condition.

The crops that were grown and the area devoted to each on the Iron River farm are given herewith: Oats, 2 acres; barley, 2 acres; corn, 2.7 acres; soy beans, 1/4 acre; sugar beets, 1/4 acre; alfalfa, 1½ acres; clover, 2½ acres.

Oats and barley were the principal crops grown on the Superior and Ashland farms.

New seedings of alsike and medium red clovers were made at each station with the object in view of growing the crops for seed. Farmers living near the sub-stations are willing to coöperate in the work and have in several instances put in new seedings of clover in order to assist in the tests of 1907. Clov-

er grows abundantly in northern Wisconsin, and we have every reason to believe will produce seed of a high grade.

Oats.—The Swedish Select oats, sown on the Iron River sub-station farm, were of a good quality and ripened evenly. No tendency to lodge was noticeable. The oats yielded 27 bushels per acre, weighing 38.6 pounds per measured bushel. The yield was not high, owing to previous cropping of the soil without adequate fertilization. At Ashland, the oats yielded 16 bushels to the acre, weighing 30 pounds per measured bushel, and at Superior, 9 bushels per acre, weighing 30 pounds per measured bushel. The low yields at Ashland were due to rust and extreme dry weather at the time of filling. At Superior the same influences with the addition of poor surface drainage, affected the yield.

Barley.—The barley was fair, but as much of the land on which the crop was grown is comparatively new and unsubdued, the low yields of 26 bushels per acre at Iron River and 16.5 bushels at Ashland were no disappointment. The barley weighed well, giving 49.2 pounds to the measured bushel. Barley does the best on a rich clay loam that has been well manured and worked deeply for a series of years. The clay soils of Superior and Ashland, after fineness and good tilth can be secured to the depth of from six to ten inches, should produce excellent crops of barley of fine grade. A system of rotation of crops has been adopted that will put the ground in the best condition in the shortest possible time.

Corn.—A test was made with dent corn on the sandy loam soil at the Iron River Station. (See Fig. 33.) A variety of yellow dent corn, which had been bred for early characteristics for two years at the Station farm, Madison, was used for the test.

The ground was put in the best possible condition and the corn planted in check rows June 2. The hills were 3 feet 8 inches apart each way, with an average of four stalks to the hill. Two cultivations were given the corn before it was laid by for the season. The corn was fully matured by Oct. 5, before heavy frost was experienced. On Oct. 1 a portion of the corn on the

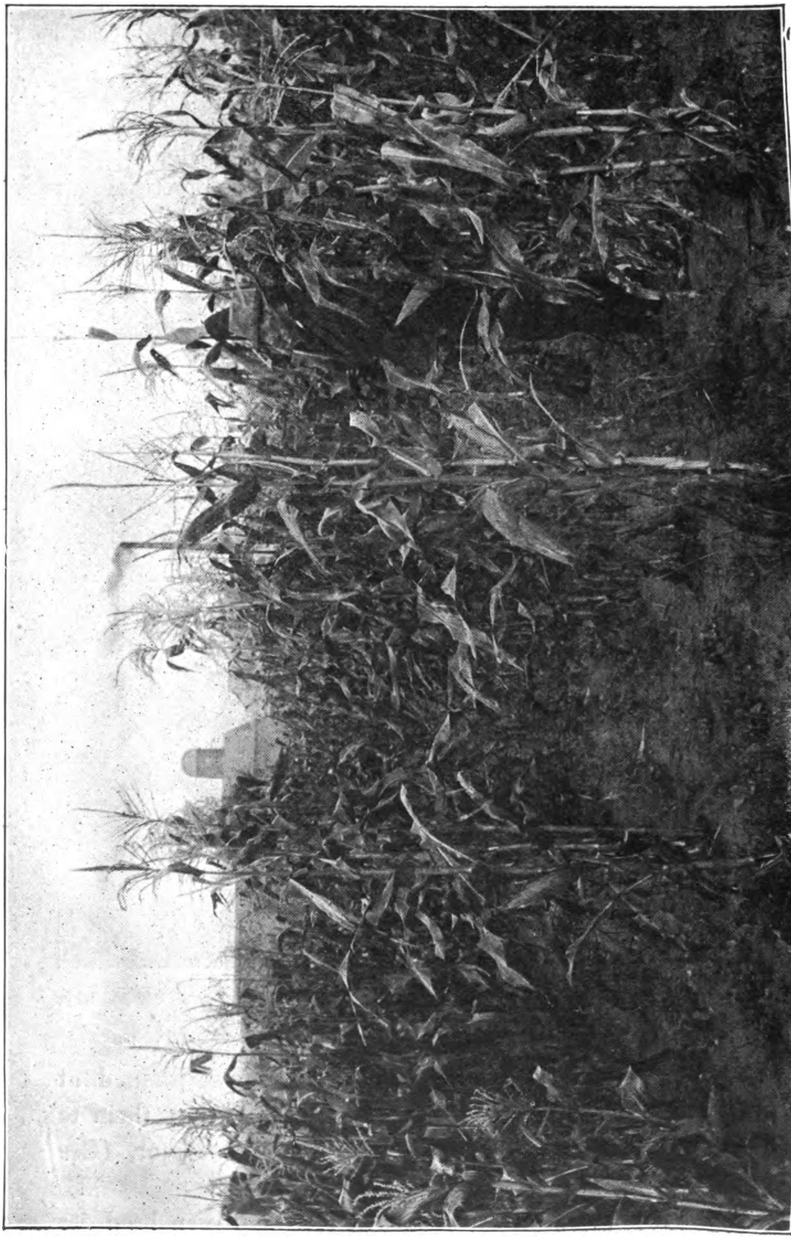

Fig. 33.—Wisconsin No. 8 corn grown on the Iron River Sub-Station farm. Yield 47.7 bushels of shelled corn and 9.2 tons of green fodder per acre.

field was cut. The weight of corn and stover together was 18,500 pounds per acre, or a trifle over nine tons, and the corn yielded 47.7 bushels shelled corn per acre.

Several bushels of good seed corn were secured for further tests next year. From the test made it seems certain that the Wisconsin No. 8 corn can be grown successfully in this latitude when put under favorable conditions as to soil and fertility.

Alfalfa.—Approximately one acre was sown to alfalfa, with barley as a nurse crop. The alfalfa came on nicely shortly after seeding and promised well. On May 18, a severe sand storm occurred that cut many plants and buried so large a portion that the stand was materially reduced. Trials with fall seeding were begun, and new experiments with alfalfa will be started next spring.

Fig. 34.—Soy beans at Iron River Sub-Station farm. Yield of well-cured hay, 2 tons per acre. Wisconsin No. 8 corn in the back-ground.

Soy beans.—One-fourth acre of soy beans was planted at the Iron River farm for the purpose of acclimating them to northern conditions and testing them as a soil renovator. (See Fig. 34.)

The soy beans were an early variety that had been bred for several years for their early maturing qualities. They were

planted on a light sandy loam June 11, and the plants appeared above ground nine days later. Bacteria-laden earth was used for inoculation purposes and the plants developed nodules abundantly upon their roots. The soy beans were not fully matured at the time of probable frosts, therefore, were cut for hay, giving a yield of two tons per acre of well-cured hay. One row of beans left in the field matured without being hurt by frost and produced a good quality of well ripened beans.

Fig. 35.—Sugar beets at the Iron River Sub-Station farm. Yield, 9 tons per acre; sugar test 16.9 per cent.

Sugar beets.—One-fourth acre of sugar beets was planted in order to test their adaptability for northern conditions. The beet seed was of the Kleinwanzleben variety and was planted May 30, in rows thirty inches apart, at the rate of twenty pounds of seed per acre. After the beets were well above ground they were thinned to a distance of eight inches between the plants in the row.

The growth, after the first five weeks, was rapid and the spaces between the rows were covered August 20. (See Fig. 35). Samples of the beets were sent to the Chemical Department for analysis and showed a test of 93.3 in purity and 16.9 in sugar content. The yield was 9 tons per acre of an exceptionally fine grade of beets. Further tests will be made next year on a wider variation of soils.

A COMPARISON OF METHODS FOR THE INOCULATION OF LEGUMINOUS CROPS.

R. A. MOORE AND E. G. HASTINGS.

In the Twenty-Second Annual Report of this Station, a detailed statement was made of the results which had been obtained from pot and field trials made to determine the relative efficiency of various methods of inoculating leguminous crops with cultures of nitrogen-fixing bacteria. During the current year similar trials have also been made.

METHODS USED.

The methods employed have been identical with those of previous years.

Disinfection of seed.—The seed was immersed for 10 minutes in a 1:1000 solution of corrosive sublimate in order to destroy any legume bacteria that might be present on the seed. The seed was immediately washed several times with distilled water in order to remove the disinfectant. Objections have been raised against such a method of procedure; if any appreciable amounts of the disinfectant were left on the seed, the legume bacteria might be destroyed when the seed was moistened with the cultures of the same. By some it has been claimed that the negative results obtained with artificial cultures were due to this disturbing factor, and that such trials were not free from error.

It does not seem probable that this objection is well taken, for it is a well known fact that mercuric bichloride combines with albuminous matter, producing a substance which has no

disinfecting action. Especially is this true when the salt is in simple aqueous solution, *i. e.,* in the absence of chlorides.* Any small traces of the salt which were not removed by the washing would, during the drying process, combine with the proteid matter of the seed and thus be removed from the sphere of action. Again, if this disturbing factor were present in the case of seeds moistened with cultures, it should also appear when the seed was moistened with soil infusions. No difficulty has been encountered in producing nodules when disinfected seed was treated with soil infusions.†

Nature and origin of cultures.—In previous trials the cultures used had been those dried on cotton. It has been found by some investigators‡ that the drying of the cotton after the immersion of the same in the culture of the organism, greatly weakens or even kills the bacteria. In order to avoid any error from this source the cultures sent out during the current year by the United States Department of Agriculture have been in liquid form. The cultures as received by us were pure and contained living organisms. Sub-cultures prepared on a solid medium, however, showed that the number of organisms was small. This may be a source of error in the use of the cultures, since the organisms that are present in the water used by a farmer in preparing the culture may overgrow the slowly developing legume bacteria.

The cultures were prepared according to the directions furnished with the same. Besides the government cultures, a number were received from the Experiment Station at Guelph, Ontario. These were already developed; the growth was to be suspended in water and the seed moistened therewith.

The soils used were from fields which had produced nodules in abundance on the legume in question. Trials were made in the case of soy beans with soil sown directly in the drill row, thus, in close contact with the seed; also with soil sown broadcast, thus in much less intimate contact with the seed. With

*Rosenau, "Disinfection and Disinfectants," p. 154–155.

†22nd Rept. Wis. Sta., 1905, p. 245.

‡Harding and Prucha, Bul. 270, N. Y. Sta.

alfalfa, trials were made with soil from alfalfa fields, and also soil infected with the organisms forming nodules on sweet-clover. The soil was sown broadcast in both cases. The arrangement of the plots was the same as illustrated in the Twenty-Second Annual Report of this Station, page 255. The soil of the trial plots was sandy and low in fertility. Repeated examinations were made of all plots in order to determine the presence or absence of nodules.

RESULTS.

The results which have been obtained are in accordance with those of previous years. The use of these artificial cultures for the production of nodules upon soy beans and alfalfa has not been successful, as no nodules were to be found upon the soy beans and upon the alfalfa grown from seed inoculated with artificial cultures. Unfortunately no conclusions can be drawn from the trials made on red clover and field peas with the Canadian cultures, as the soil of the trial fields proved to be well stocked with the organisms able to form nodules upon these legumes. It is asserted that the trials made in Canada* with these cultures have been quite successful.

The results obtained in the trials made during the last three years with artificial cultures are in accord with those obtained by numerous experiment stations throughout the country. Maine, Oklahoma, Pennsylvania, and other stations have reported negative results.

The inoculation of alfalfa and soy beans with infected soil has been very successful, nodules being produced in abundance the first year. It is generally asserted that, in order to have a thorough infection of the plants, large amounts of soil must be applied, thus making the process of applying it cumbersome and expensive. This objection is possibly well taken so far as alfalfa and similar crops are concerned, which are not sown in drills. In the case of soy beans and like crops, a small amount of well infected soil, when sown in direct contact with

*Bul. 148, Ontario Agr. Col.

the seed, is able to thoroughly infect the plants the first year. On the experimental plots seed was sown at the rate of one-half bushel per acre and an equal amount of soil sown directly in the drill row. The abundance of nodules on all plants shows the efficiency of this method.

Thus, for a large number of leguminous crops, the inoculation with soil requires no more work than the use of artificial cultures, and the usual objections, viz, introduction of plant diseases and weeds, which are urged against the use of soil, do not seem, to the writers, to have much force. In the use of soil for infecting purposes, care should be taken to use only the soil from fields that produced during the previous year an abundance of nodules on a crop of the legume in question. The organisms seem to disappear from the soil unless the legume is grown at frequent intervals.

The conclusions which were given in the Twenty-Second Annual Report were based upon the use of dried cultures. This year's trials with liquid cultures, however, show practically the same results, and until artificial cultures can be made more certain and effective, it does not seem advisable to recommend their purchase for general use. Especially is this true when the expense connected with their use is so considerable as at present, and when the questionable value of the cultures to be found on the market is considered. Nineteen cultures from three firms were examined by the Bureau of Plant Industry, Department of Agriculture;* 6 were found to be good, 3 fair, 2 poor, and 8 worthless. This would indicate that over 50 per cent of the farmers who have used commercial cultures have had their trouble and expense for nothing.

*Cir. 16. Office of Secretary, U. S. Dept. of Agr., March 1906.

FARM IMPLEMENT INVESTIGATION.

C. A. OCOCK.

During the past year this Department made investigations concerning the care of farm machinery. An attempt was made to determine the number of farm machines used by the average farmer of Wisconsin, and to obtain a conservative idea as to the care given these machines.

It is a well known fact that more farm machinery is worn out through misuse and neglect than from actual wear. Many farmers leave their $125.00 grain harvester standing out in the weather instead of buying $20.00 or $30.00 worth of lumber and building a suitable machine shed. The plow and harrow often receive the same treatment.

This condition exists generally throughout the Middle West, and Wisconsin farmers are seemingly as negligent as those of any other state. Table II aids one in judging, to some degree, the care given farm machinery.

To secure information, report blank in Table I was sent to 150 members of the Wisconsin Agricultural Experiment Association, giving them as wide a circulation as possible in the sections of the state largely devoted to farming. It is to be regretted that only about one-third of these members reported, but, from the 45 counties into which the letters went, we received reports from 29. This, of course, does not give definite conclusions, but, from observations made in traveling over the state, the table is a fairly good representation of the care which the average farmer gives his farm implements.

It will be seen in the table that it was necessary to make some addition to the report blank. The "*" in the table indicate check row corn planters. The "†" represent the persons not reporting those who shelter or do not shelter their farm tools.

TABLE I.—*Report blank.*

Wisconsin Agricultural Experiment Association.

Name.................................. P. O.........................
.... County.................... State....................
What lines of farming do you follow?.......................................
What kinds of soil exist in your locality?.................................
Please fill out the following blank so far as possible, with reference to the kind and make of implements used:

	Kind.	Manufacturer.
Plows...	....	....
Harrows...	....	....
Disc harrows...	....	....
Grain drills...	....	....
Grain seeders...	....	....
Corn planters...	....	....
Corn plows...	....	....
Potato planters...	....	....
Potato diggers...	....	....
Mowers...	....	....
Hayrakes...	....	....
Hayloaders...	....	....
Haypresses...	....	....
Grain binders...	....	....
Corn binders...	....	....
Grain separators...	....	....
Traction engines...	....	....
Corn huskers and shredders...	....	....

How many farmers out of every ten in your locality house their implements in suitable sheds when not in use?............................
How many farmers in your locality do not house their implements at all, but leave them out in the weather?.................................

This information is desired as an aid in the study of the farm machinery of the state. All information will be treated as strictly confidential and will not be given to outside parties.

TABLE II.—*Data reported by farmers on the care of farm machinery.*

Counties from which reports were received.	Barron.	Buffalo.	Clark.	Crawford.	Dane.	Door.	Eau Claire.	Grant.	Green Lake.	Iowa.	Jackson.	Juneau.	Kewaunee.	La Crosse.	La Fayette.	Milwaukee.	Monroe,	Outagamie.	Oconto.	Rock.	Sauk.	Sheboygan.	St. Croix.	Vernon.	Walworth.	Waukesha.	Waupaca.	Waushara.	Winnebago.	Total.
Number reporting from county	1	3	1	1	5	1	1	1	2	1	1	2	1	2	1	1	3	2	1	1	3	1	2	1	1	5	1	1	3	50
Plows (walking)	....	2	1	....	6	3	1	2	3	1	1	2	1	5	1	1	3	4	1	1	3	3	2	3	1	5	1	1	2	60
Plows (sulky)	1	....	1	....	4	....	....	....	....	1	1	2	1	1	1	....	....	1	...	....	1	2	....	..	....	....	1	....	3	21
Plows (gang)	...	2	....	....	1	....	....	2	1	....	....	....	....	....	....	....	....	....	....	....	....	....	..	....	...	....	....	...	1	7
Harrows (smoothing)	1	3	....	1	6	2	1	1	2	1	1	3	1	3	1	1	2	2	1	1	3	2	2	1	1	3	1	1	4	52
Harrows (disk)	1	2	....	1	4	3	....	....	1	....	1	3	....	2	1	1	2	1	1	....	3	1	1	1	....	4	1	1	2	38
Grain drills	1	1	....	....	3	3	....	1	2	1	1	2	1	1	....	1	1	1	1	1	2	....	2	....	....	2	....	1	2	31
Grain seeders	1	2	1	1	2	*3	1	1	1	1	1	2	....	2	1	....	2	1	1	....	1	2	....	1	1	4	1	....	2	36
Corn planters (hand)	....	2	....	2	....	....	....	....	....	....	....	....	....	2	....	....	2	....	....	....	....	....	....	2	....	....	....	....	....	10
Corn planters (two row)	*1	....	1	....	5	....	....	*1	2	1	2	*3	....	1	*1	1	3	2	1	1	2	1	*1	1	1	4	1	1	2	40
Cultivators (walking)	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	2	....	..	....	1	1	....	....	....	....	....	....	6
Cultivators (riding)	1	2	1	1	7	1	1	1	2	2	2	2	....	5	1	1	4	....	1	1	3	....	....	1	1	2	1	1	3	48
Potato planters	1	....	....	....	.	....	....	....	2	....	1	4	....	....	....	1	....	1	....	....	1	1	....	1	....	2	1	1	....	17
Potato diggers	1	....	....	....	....	....	....	....	1	...	...	2	....	....	....	1	....	1	1	...	1	1	....	....	....	2	1	1	....	13
Mowers	2	3	1	1	6	4	1	2	2	1	1	4	1	2	1	1	3	2	1	1	3	2	2	1	1	5	1	1	3	59
Hay rakes	1	4	1	1	5	2	1	1	2	1	1	4	1	2	1	1	2	2	1	1	1	2	2	1	1	5	1	1	3	52
Hay loaders	1	1	....	....	2	1	....	2	1	1	1	1	1	1	....	....	...	1	1	...	1	1	...	...	1	3	....	....	3	24
Hay presses	1	....	....	....	....	2	....	....	1	....	....	1	....	1	....	....	....	1	....	....	....	....	....	...	....	....	....	....	....	7
Grain binders	2	3	1	1	6	3	1	2	2	1	1	3	1	2	1	1	3	2	1	1	2	1	2	1	1	5	1	1	3	55
Corn binders	2	1	1	1	4	2	1	2	1	1	1	1	....	2	....	1	2	2	1	....	3	1	2	....	1	5	1	....	3	42
Grain separators	2	....	...	1	3	3	1	2	1	....	1	4	....	1	....	1	1	....	1	....	....	....	2	....	....	1	....	....	....	25
Traction engines	2	1	....	1	3	3	....	3	1	....	1	4	....	1	....	1	1	1	1	....	....	..	1	....	....	2	....	....	1	28
Corn huskers and shredders	2	1	....	1	1	....	....	2	2	....	1	4	....	2	....	..	....	2	....	....	1	1	1	....	....	2	....	....	1	24
Machines in suitable sheds	9	9	7	5	8	8	9	9	9	9	9	5	5	7	5	7	8	8	8	†	8	9	7	9	5	7	7	8	8	207
Those who never house	0	†	1	5	1	2	0	1	1	0	1	5	0	3	3	2	3	2	2	†	2	0	5	1	2	2	0	0	1	45

*Check rowers. †No report.

WORK OF THE DEPARTMENT OF HORSE BREEDING.

A. S. ALEXANDER.

Acting under the provisions of Chapter 116, Laws of 1905, relating to the regulation of the public service of stallions in Wisconsin, the Department of Horse Breeding of the College of Agriculture, instituted by the Board of Regents shortly after the passage of the act referred to, has to date (November 10, 1906) issued license certificates to 1,067 pure-bred stallions, 1,561 grade stallions and 4 cross-bred stallions. One grade license has since been changed to cross-bred. Some seventy-five transfers of licenses have been recorded; certificates of registry of the pure-bred stallions have, in each case, been scrutinized and compared with records in the stud books; in many instances assistance has been given in proving the identity of stallions and in procuring registry certificates or duplicates; many certificates have been found tampered with, fraudulent, or issued by bogus pedigree registers not recognized by the Department of Agriculture; in a number of cases the identity of alleged pure-bred stallions has not been proved and licenses have been issued to these horses as "grades."

Several visits have been made, by the officer in charge of the Department, to horse-breeding centers where stallions have been inspected, matters of soundness looked into, and pictures secured of typical animals of pure, grade, and "scrub" breeding as well as stallions affected with unsoundness, making them unfit for public service. As a result of this work several stallions have been retired from service and much valuable

information obtained, some of which has been used in Bulletin No. 141, entitled "The Horse Breeding Industry of Wisconsin" and containing a complete directory of owners of pure-bred, grade, and cross-bred stallions in Wisconsin. Twenty-five thousand copies of this 162 page bulletin have been published for distribution throughout the state, and, following Bulletin 127 (40,000 copies; 128 pages) on "The Principles and Practice of Horse Breeding," is expected to maintain the great interest already aroused regarding improved horse breeding, lead to further improvement in every direction, and the enactment of amended, or new legislation, for the encouragement of the industry and to place it upon the high plane of prosperity it deserves.

Bulletin No. 141 shows that the stallion license certificates have been distributed among the different breeds as follows:

TABLE I.—*Distribution of stallion license certificates.*

Breed.	Pure-bred.	Grade.
Percheron	455	694
Clydesdale	66	119
Belgian	50	52
Shire	39	106
French Draft	37	10
Suffolk	3	1
Trotter	272	325
Morgan	11	53
Thoroughbred	2	1
French Coach	54	33
German Coach	39	24
Cleveland Bay	4	10
Hackney	10	8
Pacer	3	....
Saddle	3	....
Shetland	2	7
Jack	5	3
*Non-Standard Bred	12	....
Arabian	....	6
Western	....	2
Coach	....	10
Canadian	....	4
Orloff	....	3
Unknown breeding	....	90
Total	1,067	1,561

* Being recorded, have temporarily been given pure-bred certificates, marked "Non-Standard Bred." Should, in future, have a separate class provided.

Bulletin No. 141 fully discusses all of the important phases of the subject considered, is profusely illustrated, and suggests that the following propositions should be embraced in amended, or new legislation, pertaining to the public use of stallions in Wisconsin:

1. An annual or biennial renewal license fee.
2. Adoption of a list of diseases to be considered "hereditary, transmissible, or communicable," and, consequently, subjecting a stallion to rejection as unsound.
3. Specific authority for the Department of Horse Breeding to refuse licenses to stallions known to be unsound and to revoke licenses granted to stallions since found to be unsound.
4. Authority to revoke the licenses of "scrub" stallions of "unknown breeding" and to refuse licenses to such horses in the future.
5. Institution of a plan for expert veterinary inspection of public service stallions, at appointed times and places, by inspectors duly authorized and acting under the supervision of the Department of Horse Breeding, such inspection to be known as "State Veterinary Inspection."
6. Compulsory state veterinary inspection of all stallions already granted licenses on affidavit of owner, and, at a time to be decided upon, state veterinary inspection of all stallions granted licenses when under five years of age.
7. Institution of a plan for the examination and certification of sound pure-bred stallions by the Department of Horse Breeding on voluntary request of owner, as to purity of breeding, individual excellence, breed type, character, quality, disposition, suitability, and utility, horses admitted to this class, after rigid inspection, to be known as "State Approved Stallions."

8. Stipulation as to legal posters and their legal use.
9. From Chapter 116, Laws of 1905, strike out from Section 1 the words "for profit or gain" and from Section 2 all words relating to the making of an affidavit of soundness by owner.
10. Provide a separate class and license certificate for "Non-Standard Bred" stallions recorded in American Trotting Register.

FEEDING STUFF AND FERTILIZER INSPECTION IN WISCONSIN, 1906.

F. W. WOLL AND GEO. A. OLSON.

A. INSPECTION OF CONCENTRATED COMMERCIAL FEEDING STUFFS.

In accordance with the provisions of the Wisconsin feeding stuff law (Chap. 377, laws of 1901) eighty-five different brands of concentrated commercial feeding stuffs were licensed for sale in this state for the calendar year ending December 31, 1906, by 49 different manufacturers or agents. The names of the different licensed brands, and the guarantees for protein and fat under which they were sold, with the names and addresses of the parties in whose names the licenses were issued, are shown in the following table:

A. *Licensed commercial feeding stuffs, 1906.*

No	Name of brand.	Manufacturer or agent.	GUARANTEE.	
			Prot'in	Fat.
	OIL MEALS.		Per ct	Pr ct.
1	Ground Oil Cake	Minn. Linseed Oil Co., Minneapolis	34.0	5.0
2	Ground Linseed Cake	Wm. Goodrich & Co., Milwaukee.	32.0	5.0
3	Midland Brand O. P. Ground Linseed Cake	Midland Linseed Co., Minneapolis	30.0	5.5
4	Ground Oil Cake	Northern Linseed Oil Co., Minneapolis	32.0	6.0
5	Ground Linseed Oil Cake	American Linseed Co, Minneapolis	32.0	5.0
6	O. P. Ground Oil Cake	The Red Wing Linseed Mills, Red Wing, Minn	30.0	6.5
7	Archer-Daniels Linseed Co.'s Ground Oil Cake	Archer-Daniels Linseed Co., Minneapolis	32.0	6 0
8	Viscid Oil Meal	Milwaukee Elevator Co., Milwaukee	31.0	7 5

A. *Licensed commercial feeding stuffs, 1906*—Continued.

No.	Name of brand.	Manufacturer or agent.	GUARANTEE. Prot'in	Fat.
	GLUTEN FEEDS, CORN FEEDS, ETC.		Per c t.	Pr ct.
9	**Warner's Gluten Feed**	Warner Sugar Refining Co., Waukegan, Ill	25.0	3.0
10	**Cedar Rapids Gluten Feed**	Douglas & Co., Cedar Rapids, Ia	24.5	4.0
11	**Buffalo Gluten Feed**	Glucose Sugar Refining Co., Chicago	25.0	2.5
12	**Continental Gluten Feed**	Continental Cereal Co , Peoria, Ill.	33.0*	14.0*
13	**Ajax Flakes**	Chapin & Co., Milwaukee	32.0	12.0
14	**Standard Hominy Feed**	Robt. Krull Commission Co., Milwaukee	11.0	9.2
15	**"Success" Hominy Feed**	Deutsch & Sickert Co., Milwaukee	11.0	7.0
16	**Derby Hominy Feed**	The Great Western Cereal Co., Chicago	11.0	8.0
17	**Silver Glory Hominy Feed**	W. F. Stark, Milwaukee	10.2	7.7
	MIXED CORN AND OAT FEEDS.			
18	**Excelsior Corn & Oat Feed**	The Great Western Cereal Co., Chicago	9.0	4.2
19	**Royal Oat Feed**	The Great Western Cereal Co , Chicago	6.0	2.5
20	**Victor Corn & Oat, or "C" Feed**	The American Cereal Co., Chicago	7.5	3.0
21	**Quaker Dairy Feed**	The American Cereal Co., Chicago.	12.0	3.0
22	**Vim or X Oat Feed**	The American Cereal Co., Chicago.	5.5	2.0
23	**Hominy Mixed Feed**	Peter Schmitz & Son, Milwaukee	9.05	5 66
24	**Preference Corn & Oat Feed**	P. C. Kamm & Co., Milwaukee	8.73	3.32
25	**Blue Cross Corn & Oats Feed**	E. P. Doty, Janesville, Wis	7.8	3.2
26	**Imperial Corn & Oat Feed**	Deutsch & Sickert Co., Milwaukee.	8.5	4.5
	MISCELLANEOUS DAIRY OR HORSE FEEDS.			
27	**Honest Stock Feed**	Boone Cereal Co., N. Y	10.0	4.0
28	**Dried Brewers' Grains**	John Gund Brewing Co., La Crosse, Wis	24.5	7.5
29	**Blatchford's Calf Meal**	John W. Barwell, Waukegan, Ill	25.0	5.0
30	**Blatchford's Sugar & Flaxseed**	John W. Barwell, Waukegan, Ill	27.0	10.0
31	**National Calf Food**	National Food Co., Fond du Lac, Wis	17.25	5.0
32	**Martin's Calf Feed**	J. C. Martin & Co., Mineral Point, Wis	26.0	12.0
33	**Molasses Grains**	E. P. Mueller, Milwaukee	19.5	2.73
34	**Hammond Dairy Feed**	Western Grain Products Co., Milwaukee	17.0	3.0
35	**Malt Sprouts**	Mathie Brewing Co., Wausau, Wis	29.56	.95
36	**Malt Sprouts**	Borchert Malting Co., Milwaukee.	26.75	.86
37	**Malt Sprouts**	Portz Bros. Malt and Grain Co., Hartford, Wis	25.0	.75
38	**Malt Sprouts**	A. G. Laubenstein, Hartford, Wis.	25.0	.75
39	**Malt Sprouts**	Konrad Bros. & Werner, Hartford, Wis	27.5	.6

* On dry basis.

A. *Licensed commercial feeding stuffs, 1906*—Continued.

No.	Name of brand.	Manufacturer or agent.	Guarantee.	
			Prot'in	Fat.
	MISCELLANEOUS DAIRY OR HORSE FEEDS.		Per ct.	Pr ct.
40	**Malt Sprouts**	The Kurth Co., Columbus, Wis	24.0	.6
41	**Malt Sprouts**	Rubicon Malting & Grain Co., Rubicon, Wis	27.0	.85
42	**Malt Sprouts**	C. & J. Michel Brg. Co., La Crosse, Wis	27.0	.7
43	**Malt Sprouts**	Wis. Malt & Grain Co., Appleton	26.5	.7
44	**Malt Sprouts**	Fauerbach Brg. Co., Madison, Wis.	28.5	.7
45	**Malt Sprouts**	Henry Rahr Sons' Co., Green Bay, Wis	30.0	.7
46	**Malt Sprouts**	Fred Miller Brewing Co., Milwaukee, Wis	25.98	1.46
47	**North Star Choice Malt Sprouts**	E. S. Woodworth & Co., Minneapolis, Minn	25.0	2.25
48	**Malt Sprouts**	L. Rosenheimer Malt & Grain Co., Kewaskum, Wis	25.0	.6
49	**Malt Sprouts**	Am. Malting Co., Milwaukee	23.0	1.25
50	**Viscid Concentrated Cow Feed**	Milw. Elevator Co., Milwaukee	10.98	2.34
51	**Sucrene Horse Feed**	Am. Milling Co., Philadelphia	13.5	3.5
52	**Sucrene Dairy Feed**	Am. Milling Co, Philadelphia	16.5	3.5
53	**Schumacher Stock Feed**	Quaker Oats Company, Chicago	11.0	4 0
	ANIMAL AND POULTRY FOODS.			
54	**Old Gold Poultry Food**	L. L. Olds Seed Co., Clinton, Wis.	10.5	3 0
55	**Old Gold Chick Food**	L. L. Olds Seed Co., Clinton, Wis.	10.5	3.0
56	**Blatchford's Fill the Basket Poultry Meats**	John W. Barwell, Waukegan, Ill.	33.0	10.0
57	**Globe Brand Poultry Feed**	The Albert Dickinson Co., Chicago	9.5	3 0
58	**Crescent Brand Chick Feed**	The Albert Dickinson Co, Chicago	9.5	3.0
59	**Sun Brand Chick Starter**	The Albert Dickinson Co., Chicago	10.0	3.0
60	**Queen Brand Poultry Mash**	The Albert Dickinson Co, Chicago	11.0	4.0
61	**King Brand Pigeon Feed**	The Albert Dickinson Co, Chicago	9.5	2.5
62	**Poultry Bone**	The Armour Fertilizer Works, Chicago	24.0	.5
63	**Blood Meal**	The Armour Fertilizer Works, Chicago	85.0	.2
64	**Meat Meal**	The Armour Fertilizer Works, Chicago	50.0	10.0
65	**Beef Scraps**	The Armour Fertilizer Works, Chicago	55.0	12.0
66	**Lee's Egg Maker and Chick Grower**	Geo. P. Lee Co., Omaha, Nebr	30.0	3.0
67	**Vaughan's Hen Food**	Vaughan's Seed Store, Chicago	8.0	2.0
68	**Swift's Poultry Bone**	Swift & Co., Chicago	25.0	4.0*
69	**Swift's Blood Meal**	Swift & Co., Chicago	87.0	.....
70	**Swift's Beef Scraps**	Swift & Co., Chicago	60.0	10.0
71	**Swift's Digester Tankage**	Swift & Co., Chicago	60.0	8.0†

*50 per cent. phosphates. †6 per cent phosphates.

A. *Licensed commercial feeding stuffs, 1906*—Continued.

No.	Name of brand.	Manufacturer or agent.	Guarantee. Prot'in	Guarantee. Fat.
	ANIMAL & POULTRY FOODS—Con.		Per ct.	Pr ct.
72	**Chamberlain's Perfect Chick Food**	Wernich Seed Co., Milwaukee.	10.69	3 06
73	**F. P. C. Chick Manna**	P. F. Cassel, Lansdale, Pa.; Wernich Seed Co., Milwaukee, Agents	14.01	4.75
74	**Cypher's Chick Food**	Cypher's Incubator Co., Kansas City, Mo.	12.44	3.6
75	**Cypher's Scratching Food**	Cypher's Incubator Co., Kansas City, Mo.	11.05	3.0
76	**Cypher's Laying Food**	Cypher's Incubator Co., Kansas City, Mo.	17.31	3.4
77	**Cypher's Forcing Food**	Cypher's Incubator Co., Kansas City, Mo.	12.89	3.89
78	**Purina Scratch Feed**	Ralston Purina Co., St. Louis, Mo.	11.0	3.6
79	**Midland Poultry Food No. 4**	Vaughan's Seed Store, Chicago	19.0	2.0
80	**Extra Quality Quick Meal Chick Feed**	Steinmesch & Co., St. Louis, Mo.; Kneisler Bros., Milwaukee, Agts	12.6	3.1
81	**Wernich's "Magic" Chick Feed**	Wernich Seed Co., Milwaukee	12.0	5.4
82	**Wernich's "Magic" Hen Feed**	Wernich Seed Co., Milwaukee	10.5	2.8
83	**Jewel Chick Feed**	International Stock Food Co., Minneapolis, Minn	12.18	3.20
84	**Purina Chick Feed**	Ralston Purina Co., St. Louis, Mo.	11.0	3.6
85	**Richelieu Chick Food**	Sprague, Warner & Co., Chicago	10.68	2.3

Samples of concentrated commercial feeding stuffs offered for sale in the feed stores in this state were taken throughout the year by representatives of the Station. The inspection of the feed stores and the sampling of concentrated feeding stuffs during the past year were made largely by Mr. Roy T. Harris, Assistant in the Chemical Department; the writer (W.) had charge of the office and laboratory work connected with the feed inspection, while the analyses of nearly all feed samples were made by Mr. Geo. A. Olson, Assistant Chemist. The inspections of feed stores began on January 1, 1906, and were continued with intervals throughout the year. Four hundred and ninety-four feed stores in 131 villages or cities in the state were visited during the year. The stores in some of these places were inspected a number of times, as, for instance, Milwaukee, seven times, Waukesha, Janesville and Racine, four times, and 25 cities or towns two or three times. One hun-

dred and eighty-seven samples of concentrated feeding stuffs were collected in all, which were analyzed in the chemical laboratory. In addition to these, 61 samples of feeding stuffs were forwarded for examination by farmers or dealers, making a total of 248 samples of concentrated feeding stuffs that were analyzed during the year.

The detailed results of the analyses of the samples of licensed feeding stuffs collected by us or furnished by farmers or dealers during the past year are given in Bulletin No. 142 of this Station, which also contains tables showing the analyses of a number of samples of different feeds coming under the state feeding stuff law that for various reasons had not been licensed for sale in this state, as well as analyses of feeds that are not subject to license under the law.

B. INSPECTION OF COMMERCIAL FERTILIZERS, 1906.

The following statement gives the names of twenty-three different brands of commercial fertilizers licensed for sale in this state during the current year, in accordancee with Wisconsin statutes of 1898, sec. 1494c; the names and addresses of the respective manufacturers and the guarantees for valuable fertilizer ingredients under which the brands were registered and sold in this state, will also be found in the table.

B. *Licensed commercial fertilizers, 1906.*

No.	Name of brand.	Manufacturer or agent.	GUARANTEE, PER CENT.			
			Nitrogen.	Phosphoric acid.		Potash.
				Available.	Total	
1	"Bonora" Fertilizer.....	Bonora Chemical Co, New York	15.20	4.82	......	4.68
2	Homestead, a Bone Black Fertilizer	Michigan Carbon Works, Detroit, Mich	2.06	8.0	9.0	1.5
3	Homestead High Grade Garden and Vegetable Fertilizer	Michigan Carbon Works, Detroit, Mich	2.06	8.0	9.0	6.0
4	Blatchford's Plant Grower and Land Renovator	John W. Barwell, Waukegan, Ill....................	5.0	....	4.0	4.0
5	Darling's Farmer's Favorite Brand	Darling & Co., Chicago	2.47	8.0	10.0	4.0
6	Darling's Vegetable and Lawn Fertilizer	Darling & Co., Chicago....	3.3	8.0	9.0	7.0
7	Swift's Superphosphate..	Swift & Co., Chicago.......	1.64	8.0	12.0	2.0
8	Swift's Onion, Potato and Tobacco	Swift & Co , Chicago.......	1 64	8.0	11.0	7.0
9	Swift's Bone Meal........	Swift & Co , Chicago.......	2.5	....	25.0	......
10	Swift's Truck Grower....	Swift & Co , Chicago.......	.82	8.0	10.0	4.0
11	Currie's Complete Garden and Lawn Fertilizer	Currie Bros. Co., Milw'kee	5.13	3.28	12.07	7.88
12	Grain Grower.............	The Armour Fertilizer Works, Chicago	1 65	8.0	10.0	2.0
13	Ammoniated Bone with Potash	The Armour Fertilizer Works, Chicago	2.47	6.0	8.0	2.0
14	All Soluble	The Armour Fertilizer Works, Chicago	2.88	8.0	10.0	4.0
15	Phosphate and Potash..	The Armour Fertilizer Works, Chicago	......	10.0	12.0	2.0
16	Bone Meal.........	The Armour Fertilizer Works, Chicago	2.47	....	24.0	.. ...
17	Bone, Blood and Potash.	The Armour Fertilizer Works, Chicago..........	4.11	8.0	10.0	7.0
18	Kainite.....................	The Armour Fertilizer Works, Chicago..........	.....	....	......	12.0
19	Swift's Sugar Beet Grower...................	Swift & Co., Chicago.......	2.50	8.0	11.0	5.0
20	Swift's Special Phosphate and Potash......	Swift & Co., Chicago......	......	10.0	12.0	2.0
21	Swift's Pure Ammoniated Bone and Potash...	Swift & Co., Chicago..	4.75	....	16.0	3.0
22	Sugar Beet C.............	The Armour Fertilizer Works, Chicago..........	1.65	8.0	10.0	10.0
23	Red Line Phosphate with Potash	Michigan Carbon Works, Detroit, Mich	......	10.0	12.0	2.0

The Station analyses of the licensed brands of commercial fertilizers for 1906 will be found in our bulletin No. 134. Only a few additional samples of fertilizers have been analyzed since the publication of this bulletin. These analyses will be given in the next fertilizer bulletin which will be published on or before the first day of April, 1907, in compliance with sec. 1494d, of the state fertilizer law. The texts of the state feeding stuff and fertilizer laws will be found at the close of this report.

THE WISCONSIN FERTILIZER LAW.

(Sections 1494*c*, 1494*d*, and 1494*e*, Wisconsin Statutes of 1898.)

Section 1494*c*. Every person who shall, in this state, sell or expose for sale any commercial fertilizer or any material used for fertilizing purposes, the price of which exceeds ten dollars per ton, shall affix to every package of such fertilizer or material in a conspicuous place on the outside thereof, a plainly printed statement clearly and truly certifying the number of net pounds therein, name or trade-mark under which the article is sold, name of the manufacturer or shipper, place of manufacture, place of business of the manufacturer and of the following fertilizing constituents, namely: The percentage of nitrogen in an available form, of potash soluable in water and of available phosphoric acid, soluble and reverted, as well as total phosphoric acid. Every such person shall also file with the director of the agricultural experiment station of the university of Wisconsin, in the month of December in each year, a certified copy of such statement for every such fertilizer or material bearing a distinguishing brand or trademark and which he sells or exposes for sale, which copy shall, when required by such director, be accompanied by a sealed glass jar or bottle, containing at least one pound of such fertilizer or material, and an affidavit that such sample corresponds, within reasonable limits, to the fertilizer or material which it represents in the percentage of the aforesaid constituents, which affidavit shall apply to the remaining portion of the then calendar year. Additional brands of such fertilizer or material may be offered for sale during the year, provided samples and affidavits are so filed at least one month before they are offered, in which case an analysis fee of double the usual amount must be paid. A deposit of the sample of

fertilizer shall be required by said director unless the person selling or offering for sale a fertilizer or material within this section shall certify that its composition for the succeeding year is to be the same as given in the last previously certified statement, in which case the furnishing of a sample shall be at the discretion of said director.

Section 1494*d*. Said director shall analyze or cause to be analyzed all such samples and publish the results of such analysis in a bulletin or report on or before the first day of the next succeeding April. Every manufacturer, importer, agent or seller of any such fertilizer or material shall pay annually to said director for each brand thereof sold within the state the sum of twenty-five dollars, and upon doing so and complying with the other provisions of law shall receive from him a certificate of such compliance which shall be a license for the sale of each brand thereof within the state for the calendar year for which such fee is paid. All moneys received by said director pursuant to this section shall be paid into the treasury of said station. Any person who shall sell or expose for sale any commercial fertilizer or material used for fertilizing purposes which is within the provisions of the preceding section without complying with the foregoing provisions or which contains a substantially smaller percentage of fertilizing constituents than are indicated by the printed statement thereon shall be punished by a fine of one hundred dollars for the first offense and of two hundred dollars for each subsequent offense.

Section 1494*e*. Said director shall annually analyze or cause to be analyzed at least one sample of every fertilizer or material used for fertilizing purposes sold or exposed for sale under the two preceding sections and enforce their provisions by prosecuting or causing the prosecution of every person who shall violate them. He may in person or by deputy on tendering the value thereof take a sample, not exceeding two pounds, for said analysis from any lot or package of fertilizer or any material used for fertilizing purposes which may be in the possession of any manufacturer importer, agent or dealer in this state; said sample shall be drawn in the presence of the

person from whom taken or his representatives, be taken from a parcel or number of packages which shall not be less than ten per centum of the whole lot sampled, be thoroughly mixed and divided into two equal samples, placed in glass vessels and carefully sealed and a label placed on each, stating the name or brand of the fertilizer or material sampled, the name of the party from whose stock the sample was drawn, the time and place of such taking; said label shall be signed by the director or his deputy and such person or his representative at the drawing and sealing of said samples; one of said duplicate samples shall be retained by the director and the other by the party whose stock was sampled; the sample retained by the director shall be for comparison with the certified statement named in section 1494*c*. The result of the analysis of the sample or samples so procured shall be reported to the person requesting the analysis and be published in a report or bulletin to be issued within a reasonable time.

THE WISCONSIN FEEDING STUFF LAW.

(CHAPTER 377, LAWS OF 1901; CHAPTER 143, LAWS OF 1905.)

Section 1. The term "Concentrated Commercial Feeding Stuffs," as used in this act, shall include linseed meals, cotton seed meals, pea meals, cocoanut meals, oil meals of all kinds, gluten meals, gluten feeds, maize feeds, starch feeds, sugar feeds, sucrene feeds, hominy feeds, cercaline feeds, distillers' grains, dried brewers' grains, malt sprouts, rice meals, oat feeds, corn and oat feeds, dried blood, tankage, ground beef or fish scraps, mixed feeds of all kinds, also condimental stock foods, patented and proprietary stock foods claimed to possess nutritive as well as medicinal properties, and all other materials intended for feeding to domestic animals; but shall not include hays and straws, the whole seeds nor the unmixed meals made directly from the entire grain of wheat, rye, barley, oats, Indian corn, buckwheat, sorghum, broom corn, millet and flax seed. Neither shall it include wet brewers' grains, nor wheat, rye and buckwheat brans or middlings not mixed with other substances, but sold separately, as distinct articles of commerce, nor pure grains ground together.

Section 2. Every manufacturer, company or person who shall sell, offer or expose for sale or for distribution in this state any concentrated commercial feeding stuff, used for feeding farm live stock, shall furnish with each car or other amount shipped in bulk and shall affix to every package of such feeding stuff in a conspicuous place on the outside thereof a plainly printed statement clearly and truly certifying the number of net pounds in the car or package sold or offered for sale, the name or trade mark under which the article is sold, the name of the manufacturer or shipper, the place of manufacture, the place of business and the percentages it contains of crude pro-

tein, allowing one percentum of nitrogen to equal six and one-fourth percentum of protein and of crude fat, both constituents to be determined by the methods prescribed by the director of the Wisconsin agricultural experiment station. Whenever any feeding stuff is sold at retail in bulk or in packages belonging to the purchaser, the agent or dealer, upon request of the purchaser shall furnish to him a certified copy of the statement named in this section.

Section 3. Before any manufacturer, company, or person shall sell, offer or expose for sale in this state any concentrated commercial feeding stuffs, he or they shall for each and every feeding stuff bearing a distinguishing name or trade mark, file annually during the month of December with the director of the Wisconsin agricultural experiment station a certified copy of the statement specified in the preceding section, said certified copy to be accompanied, when the director shall so request, by a sealed glass jar or bottle, containing at least one pound of the feeding stuff to be sold or offered for sale, and the company or person furnishing the said sample shall also submit a satisfactory affidavit that said sample corresponds within reasonable limits to the feeding stuffs which it represents in the percentage of protein and fat which it contains.

Section 4. Each manufacturer, importer, agent or seller of any concentrated commercial feeding stuffs shall pay annually to the director of the Wisconsin agricultural experiment station a license fee of twenty-five dollars. Whenever a manufacturer, importer, agent or seller of concentrated commercial feeding stuffs desires at any time to sell such material and has not paid the license fee therefor in the preceding month of December, as required by this section, he shall pay the license fee prescribed herein before making any such sale. The license fees received by such director pursuant to the provisions of this section shall be paid into the treasury of the university and shall constitute a special fund from which to defray the expenses incurred in making the inspections and analysis required by this act and enforcing the provisions thereof, and he shall report annually to the regents of the university of

Wisconsin the amount received and the expense incurred for salaries, laboratory expenses, chemical supplies, traveling expenses, printing and other necessary matters. Whenever the manufacturer, importer or shipper of concentrated commercial feeding stuffs shall have filed the statement required by section two of this act and paid the license fees as prescribed in this section, no agent or seller of such manufacturer, importer or shipper shall be required to file such statement or pay such fee.

Section 5. The director of the Wisconsin agricultural experiment station shall annually analyze or cause to be analyzed at least one sample to be taken in the manner hereinafter prescribed, of every concentrated commercial feeding stuff sold or offered for sale under the provisions of this act. Said director shall cause a sample to be taken, not exceeding two pounds in weight, for said analysis, from any lot or package of such commercial feeding stuff which may be in the possession of any manufacturer, importer, agent, or dealer in this state, but said sample shall be drawn in the presence of the parties in interest or their representatives, and taken from a parcel or a number of packages, which shall not be less than ten percentum of the whole lot sampled, and shall be thoroughly mixed, and then divided into equal samples, and placed in glass vessels, and carefully sealed and a label placed on each, stating the name of the party from whose stock the sample was drawn and the time and place of drawing, and said label shall also be signed by the person taking the sample, and by the party or parties in interest or their representatives at the drawing and sealing of said samples; one of said duplicate samples shall be retained by the director and the other by the party whose stock was sampled; and the sample or samples retained by the director shall be for comparison with the certified statement named in section three of this act. The result of the analysis of the sample or samples so procured, together with such additional information as circumstances advise, shall be published in reports or bulletins from time to time.

Section 6. Any manufacturer, importer or person who shall sell, offer or expose for sale or distribution in this state any

concentrated commercial feeding stuff, without complying with the requirements of this act, or any feeding stuff which contains substantially a smaller percentage of constituents than are certified to be contained, shall, on conviction in a court of competent jurisdiction, be fined not less than twenty-five nor more than one hundred dollars for the first offense, and not more than two hundred dollars for each subsequent offense.

Section 7. Any person who shall adulterate any kind of meal or ground grain or other feeding stuff with milling or manufacturing offals, or any other substance whatever, for the purpose of sale, unless the true composition, mixture or adulteration thereof is plainly marked or indicated upon the package containing the same or in which it is offered for sale; or any person who sells, or offers for sale any meal, ground grain or other feeding stuff which has been so adulterated unless the true composition, mixture or adulteration is plainly marked or indicated upon the package containing the same, or in which it is offered for sale, shall be fined not less than twenty-five or more than one hundred dollars for each offense.

Section 8. Whenever the director aforesaid becomes cognizant of the violations of any of the provisions of this act, he shall report such violations to the dairy and food commissioner, and said commissioner shall prosecute the party or parties thus reported; but it shall be the duty of said commissioner upon thus ascertaining any violation of sections two, three or four of this act, to forthwith notify the manufacturer, importer or dealer in writing and give him not less than thirty days thereafter in which to comply with the requirements of this act, but there shall be no prosecution in relation to the quality of any concentrated commercial feeding stuff if the same shall be found substantially equivalent to the certified statement named in section two of this act.

EXCHANGES.

This Station takes pride in the fact that it has on file an almost complete list of the leading agricultural papers in the United States, besides many from foreign counties, and some not strictly treating of agriculture. These papers come to the Station in exchange for its reports and bulletins. While of the highest value to those connected with the Station as the expression of agriculture experience and sentiment, they are placed where they can be read and referred to by our agricultural students, and others of the University, as well as by visitors. Any one desiring sample copies of these papers can, as a rule, secure them upon application to the publishers, at the addresses given.

FOREIGN EXCHANGES.

L'Agricoltura Alessandrina, Alessandria, Italy.
L'Agricoltura Moderna, Milan, Italy.
Agricultural Bulletin, Straits Settlement, Singapore, East Indies.
Agricultural Gazette of New South Wales, Sidney, Australia.
Agricultural Journal of the Cape of Good Hope, Cape Town, South Africa.
Agricultural Journal of India, Calcutta.
Agricultural News, Bridgetown, Barbados, West Indies.
Australian Farm and Home, Melbourne.
Boletim da Agricultura, Sao Paulo, Brazil.
Boletin del Ministerio de Agricultura, Beunos Aires, Argentina.
Bulletin de l'Agriculture, Brussels, Belgium.
Bulletin des Séances de la Société Nationale d'Agriculture de France Paris.
Bulletin of the College of Agriculture, Imperial University, Tokyo, Japan.
Bulletin of the Department of Agriculture, Kingston, Jamaica.

Chronique Agricole du Canton du Vaud, Lausanne, Switzerland.

Creamery Journal, London, England.

Extrait des Travaux de la Société Centrale d'Agriculture du Department de la Seine inferieure, Paris.

Farmer's Advocate, London, Ontario.

Farmer's Advocate, Winnipeg, Manitoba.

Farming World, Toronto, Ontario.

The Field, London, England.

Garden and Field, Adelaide, South Australia.

Irish Farming World, Dublin, Ireland.

Journal für Landwirtschaft, Berlin, Germany.

Journal of the Bath and West of England Society, Bath, England.

Journal of the Board of Agriculture, London, England.

Journal of the British Dairy Farmers' Association, London, England.

Journal of the Department of Agriculture of South Australia, Adelaide, Australia.

Journal of the Department of Agriculture of Victoria, Melbourne, Australia.

Journal of the Department of Agriculture of West Australia, Perth, Australia.

Journal of the Royal Agricultural Society, London, England.

Journal of the Royal Horticultural Society, London, England.

Kgl. Landtbruks-Akademiens Handlingar och Tidskrift, Stockholm, Sweden.

Landwirtschaftliches Wochenblatt f. Schleswig-Holstein, Kiel, Germany.

Lavoura, Rio de Janeiro, Brazil.

Live Stock Journal, London, England.

Maelkertidende, Odense, Denmark.

Milch Zeitung, Leipzig, Germany.

Mitteilungen der Deutschen Landwirtschafts-Gesellschaft, Berlin. Germany.

Natal Agricultural Journal, Maritzburg, Natal.

New Zealand Dairyman, Wellington, N. Z.

North British Agriculturist, Edinburgh, Scotland.

Nor'-West Farmer, Winnipeg, Manitoba.

O. A. C. Review, Guelph, Ontario.

Queensland Agricultural Journal, Brisbane, Australia.

Revista Agricola, Sao Paulo, Brazil.

Rural World, London, England.

Tidsskrift for det Norske Landbrug, Christiania, Norway.

Tidsskrift for Landökonomi, Copenhagen, Denmark.

Transactions of the Highland and Agricultural Society of Scotland, Edinburgh, Scotland.

Ugeskrift for Landmänd, Copenhagen, Denmark.

Weekly Times, Melbourne, Australia.

West Indian Bulletin, Bridgetown, Barbados, West Indies.

DOMESTIC EXCHANGES.

Agricultural Experiments, Minneapolis, Minn.
The Agricultural Student, Columbus, O.
American Agriculturist, New York, N. Y.
American Cheesemaker, Grand Rapids, Mich.
American Cultivator, Boston, Mass.
American Fertilizer, Philadelphia, Penn.
American Food Journal, Chicago, Ill.
American Fruit and Nut Journal, Petersburg, Va.
American Grange Bulletin, Cincinnati, O.
American Hay, Flour and Feed Journal, New York, N. Y.
American Sheep Breeder, Chicago, Ill.
American Shepherd's Bulletin, Boston, Mass.
American Sugar Industry and Beet Sugar Gazette, Chicago, Ill.
American Swineherd, Chicago, Ill.
American Thresherman, Madison, Wis.
Arboriculture, Chicago, Ill.
Blooded Stock, Oxford, Pa.
Breeder's Gazette, Chicago, Ill.
Bulletin of the National Association of Wool Manufacturers, Boston, Mass.
Cheese and Dairy Journal, Whitewater, Wis.
Chicago Daily Drovers' Journal, Chicago, Ill.
Chicago Dairy Produce, Chicago, Ill.
Chicago Live Stock World, Chicago, Ill.
Cold storage, New York, N. Y.
Colman's Rural World, St. Louis, Mo.
Commercial Poultry, Chicago, Ill.
Cornell Countryman, Ithaca, N. Y.
The Cotton Seed, Atlanta, Ga.
Creamery Journal, Waterloo, Iowa.
The Dog Fancier, Battle Creek, Mich.
Elgin Dairy Report, Elgin, Ill.
Farm and Fireside, Chicago, Ill.
Farm and Stock, St. Joseph, Mo.
Farm, Field, and Fireside, Chicago, Ill.
Farm, Garden and Poultry, Hammonton, N. J.
Farm Implement News, Chicago, Ill.
Farm Journal, Philadelphia. Penn.
Farm Life, Chicago, Ill.
Farm News, Springfield, Ohio.
Farm, Stock and Home, Minneapolis, Minn.
Farm Students' Review, St. Anthony Park, Minn.
The Farmer, St. Paul, Minn.
The Farmer and Breeder, Sioux City, Iowa.
Farmers' Guide, Huntington, Ind.
Farmers' Review, Chicago, Ill.
Farmers' Sentinel, Milwaukee, Wis.
Farmers' Tribune, Des Moines, Iowa.

Farmers' Voice, Chicago, Ill.
Field and Farm, Denver, Colo.
Flour and Feed, Milwaukee, Wis.
The Fruit Grower, St. Joseph. Mo.
The Fruitman and Gardner, Mount Vernon, Iowa.
Geflügel Züchter, Wausau, Wis.
Guernsey Herd Register and Breeders' Journal, Peterboro, N. H.
Hoard's Dairyman, Fort Atkinson, Wis.
Holstein-Friesian Register, Brattleboro, Vt.
Holstein-Friesian World, Ithaca, N. Y.
The Homestead, Des Moines, Iowa.
Horse-Shoers' Journal, Detroit, Mich.
Horticulture, Boston, Mass.
Hospodar, Omaha, Neb.
Hospordârske Listy, Chicago, Ill.
Indiana Farmer, Indianapolis.
Irrigation Age, Chicago, Ill.
Jersey Bulletin, Indianapolis, Ind.
Kansas Farmer, Topeka.
Kimball's Dairy Farmer, Waterloo, Iowa.
Lincoln Freie Presse, Lincoln, Neb.
Live Stock and Dairy Journal, San Franciso, Cal.
Live Stock Journal, Chicago, Ill.
Louisiana Planter, New Orleans, La.
Massachusetts Ploughman, Boston.
Metropolitan and Rural Home, New York, N. Y.
Michigan Farmer, Detroit, Mich.
Missouri Agricultural College Farmer, Columbia.
Modern Farmer and Busy Bee, St. Joseph, Mo.
Modern Miller, St. Louis, Mo.
National Farmer, Winona, Minn.
National Farmer and Stock Grower, St. Louis, Mo.
Nebraska Farmer, Omaha.
New York Produce Review and American Creamery, New York, N. Y.
Northwest Horticulturist, Tacoma, Wash.
Northwestern Agriculturist, Minneapolis, Minn.
Nut Grower, Poulan, Ga.
Ohio Farmer, Cleveland.
Orange Judd Farmer, Chicago, Ill.
Oregon Agriculturist, Portland.
Our Horticultural Visitor, Kinmundy, Ill.
Pacific Dairy Review, San Francisco, Cal.
Pacific Fruit World, Los Angeles, Cal.
Pacific Rural Press, San Francisco, Cal.
Poultry Husbandry, Waterville, N. Y.
Practical Farmer, Philadelphia, Penn.
Prairie Farmer, Chicago, Ill.
Reliable Poultry Journal, Quincy, Ill.
Revista Agricola, Chicago, Ill.
Rural Bee-keeper, River Falls, Wis.

Science, Garrison-on-Hudson, N. Y.
Shepherd's Criterion, Chicago, Ill.
Southern Farm Magazine, Baltimore, Md.
Southern Fruit Grower, Chattanooga, Tenn.
Southern Home, Louisville, Ky.
Southern Planter, Richmond, Va.
Southwestern Farmer and Breeder, North Fort Worth, Texas.
The Strawberry, Three Rivers, Mich.
Successful Farming, Des Moines, Iowa.
Successful Poultry Journal, Chicago, Ill.
Sugar Beet, Philadelphia, Penn.
Texas Farmer, Dallas.
Town and Country Journal, San José, Cal.
The Trade, Baltimore, Md.
Twentieth Century Farmer, Omaha, Neb.
Wallace's Farmer, Des Moines, Iowa.
Weekly Chronicle, San Francisco, Cal.
Weekly News-Scimitar, Memphis, Tenn.
Western Swine Breeder, Lincoln, Neb.
Wilson Bulletin, Oberlin, O.
Wisconsin Agriculturist, Racine.
Wisconsin Sugar Beet, Menomonee Falls.

STATE PAPERS.

Advocate, Amherst.
Weekly News Item, Antigo.
Eagle, Augusta.
Dodge County Farmer, Beaver Dam.
Recorder, Belleville.
Blade, Cadott.
Rock County Banner, Clinton.
Tribune, Clintonville.
Advance, Dartford.
Green Lake County Reporter, Dartford.
Chronicle, Dodgeville.
Entering Wedge, Durand.
Leader, Eau Claire.
Independent, Elkhorn.
Daily Reporter, Fond du Lac.
Tribune, Grand Rapids.
Journal of Burnett County, Grantsburg.
Der Landsmann, Green Bay.
Review, Green Bay.
News, Hammond.
Independent, Juneau.
Kewaunské Listy, Kewaunee.
Mirror-Gazette, Kilbourn.
News, Knapp.
Leader-Press, La Crosse.
Weekly Budget, Ladysmith.
Weekly Teller, Lancaster.
Star, Mauston.
Times, Menomonie.
Wisconsin Thalbote, Merrill.
Wisconsin Leader, Merrillan.
Der Landmann, Milwaukee.
Press, New London.
Enterprise, Oconomowoc.
La Crosse County Record, Onalaska.
Sun, Osceola.
Review, Plymouth.
Union, Prairie du Chien.
Free Press, Reedsburg.
Herald, Rib Lake.
Press, Ripon.
Polk County Press, St. Croix Falls.
Sheboygan County News, Sheboygan Falls.
Watchman, Shell Lake.
Monroe County Democrat, Sparta.
Door County Democrat, Sturgeon Bay.
Journal, Tomah.
Tomahawk, Tomahawk.
Post, Waupaca.

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From Renk Bros., Sun Prairie, Wis., one Shropshire wether lamb.

From Leopold Gans, 207 E. Madison St., Chicago, Ill., 500 pounds of distillers' grains.

From J. C. Martin & Co., Mineral Point, Wis., 50 pounds of calf feed.

From U. S. Sugar Co., Madison, Wis., 400 pounds of dried beet pulp.

From Martin H. Smith Co., New York City, 1 dozen pints of Glyco-Herion.

From Albany Hardware Specialty Mfg. Co., Albany, Wis., 2 dozen Whitcomb steel barn door latches.

From the International Stock Food Co., Minneapolis, Minn., 5 gallons of fluid dip.

From the Hygeno Disinfectant Co., Cleveland, O., 3 gallons of hygeno dip.

From W. L. Houser, Mondovi, Wis., the loan of one Percheron and one Clydesdale stallion, one Aberdeen Angus bull, and one Cheviot ram for breeding and demonstration purposes.

From Pabst Brewing Co., Milwaukee, Wis., the loan of a six horse team and equipment for demonstration purposes.

From H. A. Briggs, Elkhorn, Wis., the loan of one Percheron and one Belgian stallion for demonstration purposes.

From Richland County Horse Co., Gotham, Wis., the loan of a Percheron stallion for demonstration purposes.

From Alex. Galbraith & Son, Janesville, Wis., the loan of a Hackney stallion for demonstration purposes.

From Prof. A. S. Alexander, Madison, Wis., 32 volumes Stud Book of the Clydesdale Society of Great Britian and Ireland, 2 volumes Canadian Clydesdale stud book. Six volumes American Clydesdale stud book.

From American Clydesdale Association, R. B. Ogilvie, secretary, Chicago, Ill., secretary, volume one, French Coach stud book.

From American Shetland Pony Club., Mortimer Levering, secretary, La Fayette, Ind., 6 volumes American Shetland stud book.

From "Farmers' Review," Chicago, Ill.. Percheron and French Draft stud books.

From French Coach Horse Society of America, D. E. Willett, Chicago, Ill., secretary, volume 1, French Coach stud book.

From French Coach Registry Co., Chas. C. Glenn, secretary, Columbus, O., volume I, French Coach Horse Registry.

From Live Stock Journal, Chicago, Ill., Norman Percheron stud books.

From German Hanoverian & Oldenberg Coach Horse Association of America, J. Crouch, Lafayette, Ind., secretary, volumes I and II German Coach stud book.

From National Association of Breeders and Importers of Belgian Draft Horses, J. D. Conner, Jr., Wabash, Ind., volume I, Belgian Draft horse stud book.

From Percheron Registry Co., Chas. C. Glenn, Columbus, O., secretary, volume I, Percheron Register.

From Stericker, Arthur, Sycamore, Ill., Cleveland Bay stud book, volume II.

From Dried Milk Powder Company, New York City, museum samples of Milcora and Creamora milk powders.

From National Nutrient Company, Jersey City, N. J., museum samples of Nutrium milk powders.

From D. F. Burrell Co., Little Falls, N. Y., one 24 bottle Facile steam turbine Babcock tester.

From Farm Machinery Publishing Co., St. Louis, Mo., 1 volume Farm Machinery.

From Implement Trade Journal, Kansas City, Mo., 1 volume Trade Journal.

From Canadian Thresherman & Farmer, Winnipeg, Canada, 1 volume Canadian Thresherman Farmer.

From Threshermen's Review, St. Joe, Mich., 1 volume Thresherman's Review.

From Gas Power, St. Joe, Mich., 1 volume Gas Power.

From Avery Manufacturing Co., Peoria, Ill., the loan of one corn planter for instructional purposes.

From Aspinwall Manfacturing Co., Jackson, Mich., the loan of one potato planter and one potato cutter for instructional purposes.

From American Plow Co., Madison, Wis., one sixteen inch sulky plow for instructional purposes.

From Bateman Manufacturing Co., Grenlock, N. J., the loan of one potato planter for instructional purposes.

From Bradley Manufacturing Co., Bradley, Ill., the loan of one corn planter and exhibition platform for instructional purposes.

From the Bruley Steel Fence Post Co., Milwaukee, the loan of six indestructible fence posts for instructional purposes.

From F. H. Battles, Rochester, N. Y., the loan of two swinging cow stanchions for instructional purposes.

From J. I. Case Plow Co., Racine, Wis., the loan of one corn planter and exhibition platform for instructional purposes.

From Champion Potato Machinery Co., Hammond, Ind., the loan of one potato planter and one potato cutter for instructional purposes.

From W. B. Crumb, Forestville, Conn., the loan of two swinging cow stanchions for instructional purposes.

From J. R. Christensen, Oshkosh, Wis., the loan of one brick silo model for instructional purposes.

From Deere, Mansur & Co., Moline, Ill., the loan of one corn planter and exhibition platform for instructional purposes.

From John Deere Plow Co., Moline, Ill., the loan of one new Deere

sixteen inch sulky plow and one new Elk corn cultivator for instructional purposes.

From Emerson Manufacturing Co., Rockford, Ill., the loan of one disc gang plow, one No. 10 corn planter, one fourteen inch moldboard gang plow, and one No. 5 standard mower for instructional purposes.

From Fuller & Johnson Manufacturing Co., Madison, Wis., the loan of one corn planter, and one six H. P. open jacket gasoline engine for instructional purposes.

From Hayes Pump & Planter Co., Galva, Ill., the loan of one corn planter for instructional purposes.

From Hunt, Helm, Ferris & Co., Harvard, Ill., the loan of one swinging cow stanchion for instructional purposes.

From International Harvester Co., Chicago, Ill.:

The loan of one six H. P. portable gasoline engine, one six H. P. stationary gasoline engine, one three H. P. vertical gasoline engine, and one two H. P. sectional gasoline engine for instructional purposes.

From Deering Division the loan of one six foot Deering grain binder.

From Champion Division the loan of one six foot Champion binder.

From McCormick Division the loan of one six foot McCormick binder and one binder attachment.

From Milwaukee Division the loan of one six foot Milwaukee grain binder.

From Osborne Division the loan of one six foot Osborne grain binder for instructional purposes.

From Janesville Machine Co., Janesville, Wis., the loan of one corn planter and exhibition platform for instructional purposes.

From J. I. Case Threshing Machine Co., Racine, Wis., the loan of one twenty H. P. traction engine, one fifteen H. P. traction engine, one corn husker and shredder, one water tank, one tank pump and suction hose, and one drive belt for instructional purposes.

From Louden Machine Co., Fairfield, Iowa, the loan of four swinging cow stanchions for instructional purposes.

From Minneapolis Silo Co., Minneapolis, Minn., the donation of one section of stave silo for instructional purposes.

From Moline Pump Co., Moline, Ill., the loan of one three H. P. gasoline engine, one three H. P, sectioal cut gasoline engine and exhibition platforms.

From Manson Campbell Co., Detroit, Mich., the loan of one Chatham fanning mill and corn grader for instructional purposes.

From MacDonald Bros., Pleasant Hill, Mo., the loan of one four ton wagon platform scale for instructional purposes.

From Newton Co., Batavia, Ill., the donation of one Newton improved animal tie for instructional purposes.

From E. Prescott, Boston, Mass., the loan of two swinging cow stanchions for instructional purposes.

From O. H. Robertson, Forestville, Conn., the loan of two swinging cow stanchions for instructional purposes.

From D. M. Sechler Carriage Co., Moline, Ill., the loan of one Black Hawk corn planter and exhibition platform for instructional purposes.

From Simplicity Tank Heater Co., Sparta, Wis., the loan of one Simplicity tank heater for instructional purposes.

From Van Brunt Manufacturing Co., Horicon, Wis., the loan of one seventeen disc six inch drill, one shoe and bar, and one sample feed gate for instructional purposes.

From Wiard Plow Co., Batavia, N. Y., the loan of one bean harvester for instructional purposes.

From Walter A. Wood Harvesting Machine Co., Hoosack Falls, N. Y., the loan of one six foot grain binder for instructional purposes.

From Wood Automatic Corn Planter Co., Milwaukee, Wis., the loan of one automatic planter attachment for instructional purposes.

From F. & J. H. Welcher, Newark, N. J., the loan of two swinging cow stanchions for instructional purposes.

From Creamery Package Manufacturing Co., Chicago, Ill., 3 Turbine Testers, 2 tread power (Victor) for hand separators, 8 bottles Starter Culture, 200 catalogue supplies, 1 small Disbrow churn, and 1 Trunion Starter can—30 gallons, 3 Twentieth Century Milk Heaters, Farrington Pasteurizer, Farrington Cream Ripener, Boyd Cream Ripener, Victor Starter cans, 2 Wizard Agitator and Cream Pump, 2 Wizard Testers, 2 Victor Foot Powers, 20th Century Hand Tester 6 bottle, 20th Century Hand tester 16 bottle, 2 20th Century Hand tester 12 bottle, Victor Turbine tester 24 bottle, 2 Wizard Turbine Tester 24 bottle, 2 Wisconsin Curd Tests, Disbrow Churn, Wizard Tester 8 bottle, and Victor Skim Milk Pasteurizer.

From O. Douglass, Boston, Mass., 8 bottles Starter Culture.

From Elov. Erickson, St. Paul, Minn., 8 bottles Starter Culture. Packages pure culture Starter.

From J. I. Case Threshing Machine Co., 200 copies "Science of Successful Threshing."

From Vermont Farm Machine Co., Bellows Falls, Vt., 1–10 bottle Agos tester.

From C. W. Putnam & Sons, Aurora, Ill., 200 Patrons' Creamery milk account books.

From International Salt Co., Wyandotte, Mich., 1 barrel Wyandotte Butter Salt, 1 barrel Wyandotte Cheese Salt.

From Chr. Hansen's Lab. Little Falls, N. Y., packages Lactic Acid Culture for starter.

From Parke, Davis & Co., Detroit, Mich., Capsules Flavorone for starter making.

From C. Richardson & Co., 1–Frink oil test chart.

From D. H. Burrell & Co., Little Falls, N. Y., tester repairs and separator supplies, Simplex Separator, Simplex Churn No. 6, Facile Turbine Tester, 36 bottle, repetition, Facile Hand Tester, 6 bottle, Facile Hand Tester, 24 bottle, and Facile Tester Turbine, 24 bottle.

From Jensen Manufacturing Co., Topeka, Kansas, Jensen Pasteurizer and Cooler and 2 Haugdahl Starter Cans.

From Vermont Farm Machine Co., Bellows Falls, Vt. Agos Tester 20 bottle turbine, U. S. Separator No. 5, U. S. Separator No. 6, U. S. Separator No. 7, U. S. Separator No. 2½ and Intermediate, Agos Tester 12 bottle hand, Agos Tester 24 bottle turbine, Agos Hand Tester No. 5, Agos Hand Tester No. 6, and Agos Hand Tester No. 7.

From De Laval Separator Co., Chicago, Ill. Alpha Acme Separator, Baby Alpha Hand Separator No. 1, Baby Alpha Hand Separator, No. 2, Daisy Hand Separator and Alpha Hummingbird Separator.

From McKinnon & Co., Sheboygan Falls, Wis. Combination Cheese Press.

From Hastings Industrial Co., Chicago, Ill. National Separator No. 14, National Separator No. 12, Midget Hand Separator, and Dairymaid Hand Separator.

From Empire Manufacturing Company, Bloomfield, N. J. Empire Separator No. 1A, 1 Hand Separator No. 1B, and Hand Separator No. 2B.

From Sharples Manufacturing Company, Chicago, Ill. Russian Tester, Triumph test bottle shaker, Sharples Separator, Accelerator, Hand Separator No. 4, Hand Separator No. 6 and Hand Separator No. 9.

From A. H. Barber Company, Chicago. B. & W. Heater.

From Milo D. Beach, Litchfield, Conn., Triumph test bottle shaker.

Cornish, Curtiss & Greene, Fort Atkinson, Wis., American butter printer.

Fuller & Johnson Manufacturing Co., Madison, Wis., gasoline engine.

From University of Chicago, four cultures of Bacteria, Department of Bacteriology.

From M. G. Busch, Copenhagen, Denmark, Danish milk pail.

From Dr. E. Von Freudenreich, Berne, Switzerland, two cultures of Bacteria.

From the Nitrate of Soda Propaganda, N. Y., 200 pounds of Nitrate of Soda.

From the German Kali Company, a complete set of samples of the natural and manufactured potash salts.

From Mr. De Witt Van Ostrand, Phillips, Wis., for a set of photographs illustrating the clearing of marsh lands.

From Prof. C. E. Saunders, Ottawa, Canada, three pounds each of Twentieth Century & Golden Fleece oats.

From Prof. T. L. Lyon, Lincoln, Nebraska, five pounds Kherson oats.

From Supt. Geo. McKerrow, Pewaukee, Wis., one bushel smut nose flint corn.

From Wahl-Henius Institute of Fermentology, Chicago, Illinois, two pounds each of "Odessa," "Royal," "Mensury," "Claude," barley.

From Guelph Experiment Station, Guelph, Canada, samples of oats "Daubeny," "Joanette Black," "Liberty."

From J. L. Owens Co., Minneapolis, Minn., New Superior Fanning Mill.

FINANCIAL STATEMENT.

The Wisconsin Agricultural Experiment Station, in account with the United States appropriation.

1905–1906.	Dr.	Cr.
To receipt from treasurer of the United States as per appropriation for the year ending June 30, 1906, under the act of Congress, approved March 2, 1887....	$15,000 00	....
By salaries...	....	$8,509 00
By labor....	....	1,503 75
By publications....	....	39 70
By postage and stationery....	....	116 80
By freight and express....	....	50 00
By heat, light, and water....	....	192 34
By chemical supplies....	....	464 60
By seeds, plants, and sundry supplies....	....	1,179 12
By fertilizers....	....	80 00
By feeding stuffs....	....	544 50
By library....	....	425 57
By tools, implements, and machinery....	....	244 25
By furniture and fixtures....	....	285 92
By scientific apparatus....	....	621 45
By live stock....	....	53 00
By traveling expenses....	....	308 43
By contingent expenses....	....	15 00
By building and repairs....	....	366 57
	$15,000 00	$15 000 00

We, the undersigned duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the Wisconsin Agricultural Experiment Station for the fiscal year ending June 30, 1906; that we have found the same well kept and classified as above, and that the receipts for the year from the treasurer of the United States are shown to have been $15,000, and the corresponding disbursements $15,000, for all of which proper vouchers are on file and have been by us examined and found correct.

And we further certify that the expenditures have been solely for the purposes set forth in the act of Congress Approved March 2, 1887.

(Signed) MAGNUS SWENSON, *Chairman.*
L. S. HANKS,
W. J. MCELROY,
Executive Committee.

ATTEST;
E. F. RILEY,
Custodian.

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